THE MONTHLY EVENING SKY MAP

VOL. LIV NO. 508

AMATEURS GATHER IN PHILADELPHIA (See Page 14)

FIFTY CENTS

NOVEMBER • DECEMBER 1960

OBSERVE MARS THIS YEAR AT CHRISTMAS — with your

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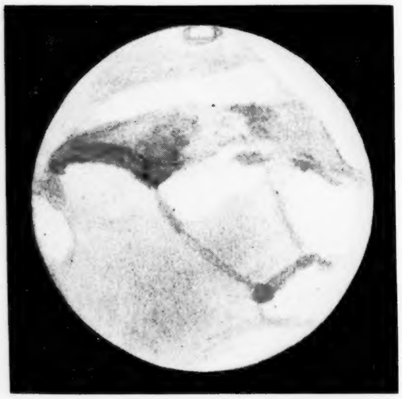

Mars on October 13, 1958, as seen through an 8" f/7 De Luxe ASTROLA Reflector. The drawing was made when the Martian longtitude of the central meridian was 210°-215°, and the disk was 17.2 seconds of arc in diameter. The power used was 360-450, with seeing fairly good, but transparency only fair.

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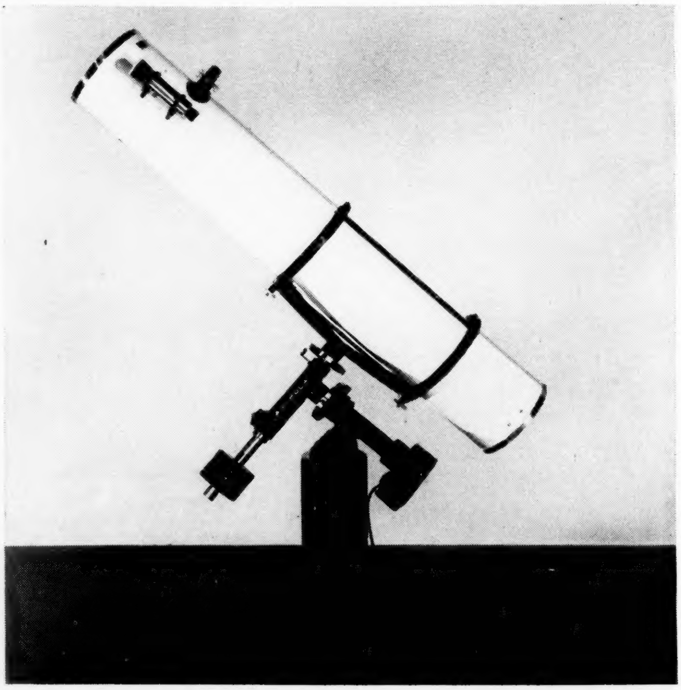

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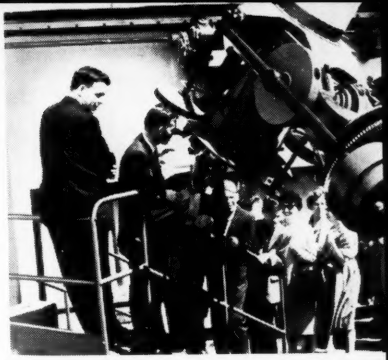
FOUNDED IN 1905 . . .
THE AMATEUR'S OWN MAGAZINE

THE MONTHLY EVENING SKY MAP



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COVER PHOTO

Hundreds of amateurs attending Astronomical League Convention at Haverford College line up for view of solar prominences through the 10-inch Zeiss refractor of the Franklin Institute in Philadelphia. Details of Convention may be found on page 14.

A YEAR-END STATEMENT

AFTER A MANNER of speaking, the SKY MAP is celebrating its own "winter solstice" in December, for it marks the first anniversary of the half-century-old magazine's initial issue under new management. The present SKY MAP is admittedly a departure from the periodical's first 50 years—larger, more modern and more ambitious—but this in no way reflects upon the contribution made to amateur astronomy by the previous publishers during a time when the SKY MAP was the only generally circulated publication directed toward the amateur of astronomy.

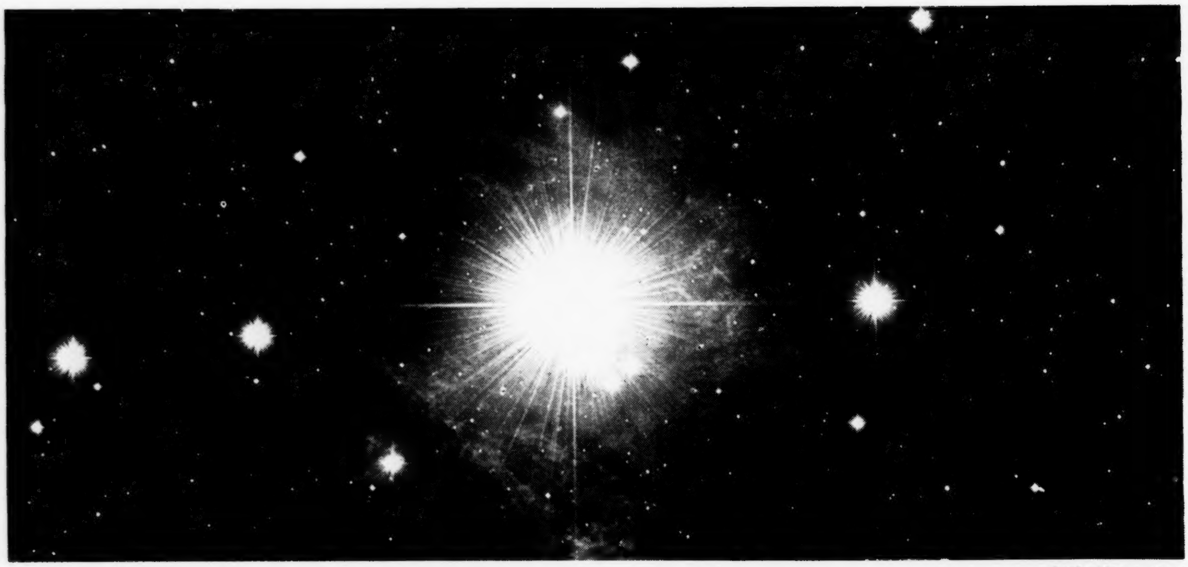
Unlike the sun at the December solstice, we are not "standing still." The magazine has tripled in size and in circulation since we took it over in late 1959, and we feel that this is a reflection of the need for a publication in the field slanted to the general reader and the average amateur. As we have said before, there is so much to talk about in the field of astronomy these days, and so many people to talk to about it.

We are also pleased to have attracted the interest and support of an increasing number of advertisers in the field of astronomy and telescopic equipment. Informative advertising is an important part of a magazine in a field such as astronomy, and we feel that they are an important addition to the reader interest of the SKY MAP.

We welcome with pleasure our many new advertisers, especially the presence of the Sky Publishing Corporation, publishers of many charts, atlases, and books and—primarily—SKY & TELESCOPE magazine. S&T—as it is familiarly called by its many readers—will be completing its 20th year of publication shortly. In these two short decades, its editor-publisher, Charles A. Federer, Jr., and his associates have brought a new dimension of astronomical journalism to the field. The magazine is slanted both to the amateur and to the professional astronomers and allied scientists of the world, for whom it is "must reading" each month. Its coverage of technical developments in the field of astronomy, satellite research and development, optics, physics and electronics is both broad and readable, without sacrifice of scientific accuracy (the magazine's high standard of accuracy throughout is an example to be admired). Yet, it offers considerable for the non-professional or less advanced reader, and no amateur, young or inexperienced as he may be, can read its pages without finding articles, features and photographs at his level of interest.

If we felt for a moment that the SKY MAP would be competitive with SKY & TELESCOPE, we would never have launched the new magazine. Today, however, interest is so widespread, and so much is being done, that we felt there was a need for a publication that would complement S&T, a magazine slanted to the amateur and observer. Our only sense of competition is that of maintaining the high standards—commensurate with the SKY MAP's intended level—set for us by SKY & TELESCOPE. We expect that many readers will find S&T to be of interest, and that both publications may share their attention in years to come. The SKY MAP's growing acceptance indicates that the "launching" has been successful—we shall try to see to it that we maintain the proper equilibrium to remain "in orbit."

So, it is with a mixture of humor and humility, plus a bit of young-blooded brashness, that we turn to the east and wish two decades full of good wishes to "the junior publication from Massachusetts," and to our friends on its staff who have been so helpful and encouraging in our effort to revivify the MONTHLY EVENING SKY MAP in its 51st year.



Lick Observatory

WHAT WAS THE CHRISTMAS STAR?

DONALD D. DAVIS
Fels Planetarium

WITH ANOTHER CHRISTMAS SEASON approaching, preparations are being made in many of the world's planetariums to present the traditional lectures on the Star of Bethlehem. These often beautiful presentations tell what might have taken place in the sky at the time of the birth of Christ. Often, however, certain possibilities are discussed which are appealing to the imagination but which are not very likely to have occurred.

It is sometimes said that there are many possible explanations for the phenomenon we call the Star of Bethlehem. With this we must agree, for almost anything is possible, and it is not our purpose in this discussion to enter into the subject's theological aspects. But the number of *probable* astronomical explanations is limited to one, as we shall see when we consider the astronomical and historical facts available to us. While many of us will choose to accept the explanation which seems most appealing (or perhaps to accept none of the explanations at all), it should be interesting to learn what facts are known by the astronomer and the historian in connection with the Biblical account of the star (Matthew 2:1-10). We shall see that only one known event fits the circumstances described there.

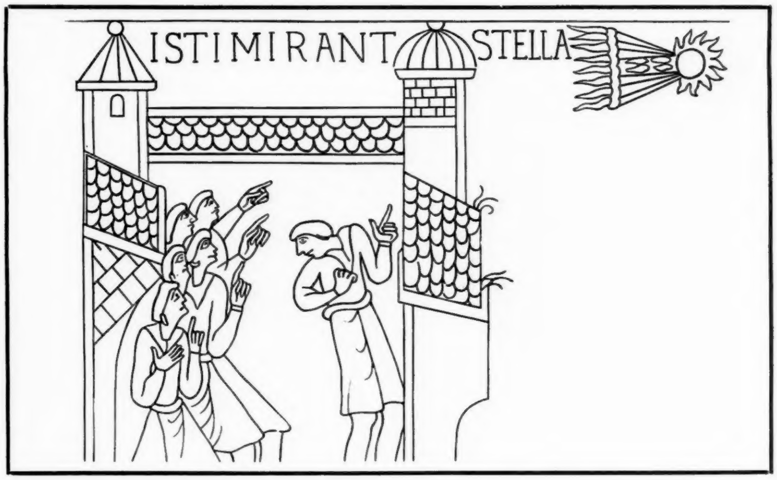
It is first necessary to clarify a few points about the probable date of the birth of Jesus Christ. It is extremely unlikely that December 25 was the actual date of the first Christmas if we accept the statement in Luke 2:8—"And there were in the same country shepherds abiding in the field, keeping watch over their flock by night." Shepherds in Judea were out at night with their flocks at only one time of year: in the spring, when lambs were born. In December the rainy season made Judea rather unpleasant, and it is unlikely that sheep or shepherds would have been found outdoors in the hills of that country. Probably, then, Christ was born in the spring of the year. But what year? More on that in a moment; we must first find why we celebrate Christmas on the twenty-fifth day of December, not on some day in March, April or May.

We are told that the early Christions celebrated their religious feasts at times when the Romans were engaged in some pagan festival. No one bothered to check who was celebrating what, and thus the Christians could celebrate openly without fear of persecution! The Romans had a series of festivals in December every year called "the Saturnalia," an acknowledgment to Saturn for the crops of the year. During this feast the winter solstice occurred — the time when the sun is lowest in the sky for the year, marking the first day of winter. When Julius Caesar established his calendar in 45 B.C., the date of the winter solstice was December 25. It continued as the center of the Roman celebrations and became also the date of the surreptitious, later open, observance of Christmas. And so the great Christian religious feast has a decidedly astronomical background.

But what of the year in which Jesus was born? This being the year 1960 of the Christian Era, it would be natural to suppose that Christ was born 1,960 years ago. But to tell the truth, we do not know the exact year in which He was born. There is a strong suspicion that Christ was born at least four and perhaps eight years before the year we call 1 A.D., and there are many reasons for this.

The custom of dating events from the birth of Christ began, not with the early Christians, but with a sixth-century Scythian monk named Dionysius Exiguus, or Denis the Short, as we would call him today. Dionysius searched Roman and Hebrew histories and decided that he was living in the year 533 after the birth of

Appearance of Halley's Comet in 1066 at time of Battle of Hastings was depicted in Bayeux Tapestry. The 1066 passage was fourteenth since 11 B.C. apparition, which has been suggested as a possible explanation of Christmas Star. Comet pre-dated currently accepted birthdate of Christ by several years.



Christ, or 533 A.D. (*Anno Domini*: "in the year of our Lord").

Dionysius did not know that Augustus Caesar ruled the Roman Empire unofficially for four years before having himself declared Emperor by the Roman Senate. Depending on the historical sources he used, Dionysius may or may not have introduced a discrepancy of four years into his chronology. Historians believe that he did make a mistake and that Christ was born at least four years before the year we call 1 A.D.

Surely Christ was born during the reign of Herod the Great. The second chapter of St. Matthew makes this evident. Today, through astronomy, we can determine the approximate date of Herod's death. Flavius Josephus, a Hebrew historian, tells us that Herod was in his final illness on the date of an eclipse of the moon. It was a partial eclipse, just before the spring, observed from Jericho. The only eclipse which has the proper qualifications occurred on March 13 of the year we call 4 B.C. Josephus goes on to say that Herod died shortly thereafter and that there were seven days of mourning, after which the Passover feast occurred. Since the Passover began with the full moon of April 12 that year, it is safe to say that Herod died between March 13 and April 5. If Jesus were indeed born "in the days of Herod the King," He must have been born by March of the year 4 B.C.

We now have a date *after* which Christ could not have been born. We can also approach the question from the opposite direction, attempting to find a date *before* which He could not have been born. In 1923 an inscription was found on the ruins of an old Roman monument in Ankara, Turkey. It turned out to be a list of the three great taxations that took place during the reign of Augustus Caesar. The first was in 28 B.C., the second in 8 B.C., and the third in 14 A.D., by our method of reckoning. Clearly, the first taxation is much too early to be connected with the first Christmas, unless we have made great errors in reckoning time. The third taxation, that of 14 A.D., is far too late: it is almost 20 years after the death of Herod. The only taxation which seems to fit the conditions we impose is that of 8 B.C. The taxation is important because of the mention made of it in the Gospel according to St. Luke. It is because of the taxation that Joseph and Mary were in Bethlehem at the time of the birth of Christ.

A period of likelihood has now been established, spanning the years from 8 B.C. to 4 B.C. It is possible that we can narrow this period by making a reasonable assumption. The great taxation of the Roman Empire, although decreed in Rome in 8 B.C., probably did not begin in Judea until some later time. The imperial tax collectors probably worked their way from province to province across the vast Roman Empire under conditions of slow transportation. It seems quite likely that they might not have reached Bethlehem until 7 or even 6 B.C.

We can now begin to look for astronomical events which occurred in the period 8-4 B.C. A bright comet has been mentioned as a possibility for the "star," and it is known that Halley's Comet appeared over the ancient world in 11 B.C. Its passage was recorded by the Chinese. The comet has been observed at intervals of about 76 years, at least since 240 B.C., and will make its next appearance in 1986.

Yet 11 B.C. is too early a date to be connected with the birth of Jesus, if our previous guesses are correct. Of course, it is possible that the early Christians, remembering the life of Jesus and the circumstances of his birth, may also have remembered the 11 B.C. passage of Halley's Comet, and mistakenly assumed that it appeared at about the time of His birth. Historical memory often suffers from lapses and inaccuracies. All we can say is that Halley's Comet appeared too early to be a true harbinger of the first Christmas, as we reckon it. The available records make no mention of any other bright comets observed in the period of years between 8 B.C. and 4 B.C., although comets were observed both before and after that period. Strictly speaking, then, we should rule out a comet as a possibility for the Star of Bethlehem.

An often-mentioned possibility is the *nova*, or "new star." Several times each century bright stars are found in areas of the sky where no star had been seen before. We know these today for what they are—stars normally too faint to be seen with the naked eye, which, for some reason, explode into conspicuous brightness for a time. This type of phenomenon seems exactly what we seek. Alas, a look at the existing records shows that novae were observed both before and after our four-year period, but none during that period. It appears, therefore, that a nova must also be ruled out as a possibility for the Star of Bethlehem, attractive though it seems.

The possibility of a meteor or a meteor shower has been suggested, but this does not deserve serious consideration. A meteor is visible for an instant, a meteor shower for a few nights at most. Yet the Magi are said by St. Matthew to have seen the star (whatever it was), gone to Palestine, talked to Herod, *seen the*

star again, and followed it to "the place where the young child was." They could not have observed the same meteor or meteor shower after their journey to Palestine, which must have taken months. And the likelihood of *two* meteors or meteor showers of sufficient intensity to attract the attention of the Magi and so placed in the sky as to lead them in the right direction each time seems quite small.

The three possibilities so far discussed do not seem to have occurred at the right time in history to be called the Star of Bethlehem. What, then, did occur in the period 8 B.C.-4 B.C. of sufficient importance to impress itself upon the minds of the Magi, and later the Scripture writers? The answer may still lie within the ken of the astronomer.

In 1604 the German astronomer Johann Kepler observed a conjunction of the planets Jupiter and Saturn. Whenever one planet overtakes another as the two move eastward across the sky, we say that they are in conjunction. Ordinarily there is nothing unusual in this—Jupiter moves along the ecliptic more swiftly than Saturn and overtakes it every twenty years or so. But the conjunction of 1604 was a triple or "great conjunction." Jupiter overtook Saturn, reversed its direction and passed Saturn again; then it changed direction and passed Saturn a third time.

This type of conjunction, while rarer than an ordinary conjunction, is not an event of extreme rarity. It can occur whenever Jupiter overtakes Saturn and is at the same time in opposition to the sun. When a planet is in opposition to the sun it rises when the sun sets and is on the meridian at midnight. Some time before opposition the planet appears to reverse its direction among the stars and move westward. After opposition it apparently reverses its direction once more and again moves eastward. This reversal of direction which so mystified the ancients is called *retrograde motion:* it occurs because the earth moves around the sun faster than the planet. Our earth passes the slower-moving planet when it is at opposition, and for a time the planet *seems* to move backward among the stars.

It was while Jupiter was undergoing retrograde motion in 1604 that it "overtook" Saturn in that famous great conjunction. This event, which last took place in 1940, can happen every 125 years, although it usually occurs half as often. Kepler, who was something of a mystic, became interested in the conjunction and sat down to calculate when it had happened previously. He found that it had occurred in the year 7 B.C. and believed it to be the omen that the Wise Men had seen. Whether or not this triple conjunction was seen by the Magi, it is impossible for us to say. What we can say is that we have found the only spectacular astronomical event known to have taken place within the time span we have selected as the probable period for the birth of Jesus. Perhaps this was the Star of Bethlehem.

As further evidence for our theory, we note that the great conjunction of 7 B.C. had as its star-background the constellation Pisces, the Fishes. This zodiacal star-group was the symbol of the whole Hebrew nation in the astrological thinking of the ancient world. To astrologers such as the Magi, a triple conjunction of Jupiter and Saturn in Pisces could hardly have meant anything except that something was about to happen to the Hebrews.

It has been pointed out that the Hebrews were not interested in astrology at this time in history, but that fact cannot affect things one way or the other. It is sufficient to suppose that the Magi, who *were* interested in astrology, saw the phenomenon and acted upon it.

While a triple conjunction of Jupiter and Saturn can occur as often as every 125 years, a triple conjunction of these same planets in the constellation Pisces is much more rare. This can happen roughly every 805 years. Such a conjunction took place in 7 B.C., in 799 A.D., and in 1604, when Kepler noticed and investigated it. The same omen is said to have been seen in the sky three years before the birth of Moses (1617 B.C.), so we can see why the Magi might have been expecting another leader of the Hebrews to come forth.

As if a conjunction of Jupiter and Saturn were not enough, something else happened in the sky of the Magi. In the spring of 6 B.C. the planet Mars joined Jupiter and Saturn in Pisces, and for a while the three formed a small triangle. Some think that this was the omen the Wise Men saw, but it is known that the grouping was in the morning sky, too close to the sun for easy observation. The triple conjunction of Jupiter and Saturn was surely enough of a celestial phenomenon to serve the purpose.

The reader has perhaps been wondering why we have been considering such things as comets and planetary conjunctions in this search for the Star of Bethlehem, for neither of these phenomena resembles a star. The answer is given by the limited vocabulary of the people of the time and place we are considering. To them anything in the sky was a "star": a comet was a "bearded star," a planet was a "wandering star," a meteor was a "falling star," and sometimes whole constellations were called "stars" (in the Old Testament story of Joseph, the zodiacal constellations are referred to as the "twelve stars"). So we see that any unusual celestial event, if it had occurred at the right time in history, could easily have qualified as the "Star" of Bethlehem. But we have found only one event which is *known* to have taken place within the probability interval we have selected for the birth of Jesus Christ.

To some of us, none of the scientific theories will be satisfactory. Some will choose to believe that the Star of Bethlehem was seen only by the Magi, that it was a miracle. It is not our purpose here to comment on miracles, but in the broadest sense we could say that all things are miraculous — life itself is a kind of miracle.

But is it after all really important to know what the Star of Bethlehem was, or even whether it existed as a scientific phenomenon? What is important is that the story of the Star of Bethlehem serves as the background for the birth of the man called Jesus of Nazareth, whose life and teachings have had a profound influence on the subsequent history of man.

THE RED PLANET MOVES CLOSER

ONCE AGAIN MARS is moving in for a fleeting, fascinating, and possibly frustrating, visit with the Earth.

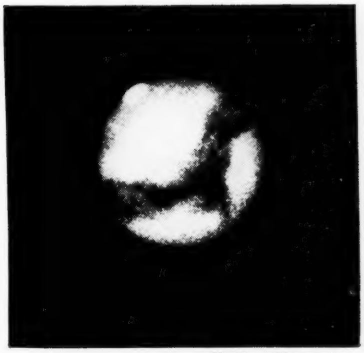
Although it is wintertime on our earth, the northern hemisphere of Mars is enjoying the spring season of its 687-day year. Not being Martians, however, we will have to experience Martian spring vicariously, for this is not an especially favorable approach of Mars to the earth. This opposition, as the comparatively close passages to the earth of Mars and the other outer planets are called, finds the ruddy planet nearing its aphelion distance from the sun (some 63 million miles in February of 1963). Opposition will occur on Dec. 31st; the closest point on Christmas night, when it will be 56,600,000 miles from the earth.

On page 18 of this issue planetary observer and telescope maker Tom Cave discusses the problems of observing Mars, but it might be appropriate for a moment to prepare ourselves in advance and become a bit more familiar with Mars itself. What are we looking at, and what will we see?

Mars is just a bit more than one-half the size of our earth—4,200 miles in diameter. Its distance from us gives it an apparent angular size of just 15″-16″ of arc at this opposition; just a bit more than 11″ on Nov. 1st. This is certainly not impressive when we realize that this opposition size is but one-third the size of Jupiter's disc—but when we learn that a magnification of 100 times in our telescopes will give Mars an *apparent* size equal to that of a *full moon* our interest is somewhat rekindled.

Knowing what to look for and how to look for it—and then *doing* it—carries the beginning observer far along the road to success in his Martian studies. The writer recalls that he first began his serious Mars observations in 1939, when it was very close to the earth, yet he seemed to improve his delineation of Martian detail with each future opposition, even though he knew that the planet was farther away at each apparition. The improvement was partly instrumental (from a two-inch up to a ten-inch), but it was mainly due to an increasing ability, through training of the eye, to discern detail. Regular observation of Mars, beginning in early November and continuing into February, is guaranteed to "double" the aperture of your telescope, figuratively but practically speaking. The telescope remains the same, but your eye begins to recognize more and more detail.

In December and January, Mars will be in the middle of a 199-day spring in its northern hemisphere. This is the longest season in that hemisphere, since the eccentricity of



Yerkes Observatory

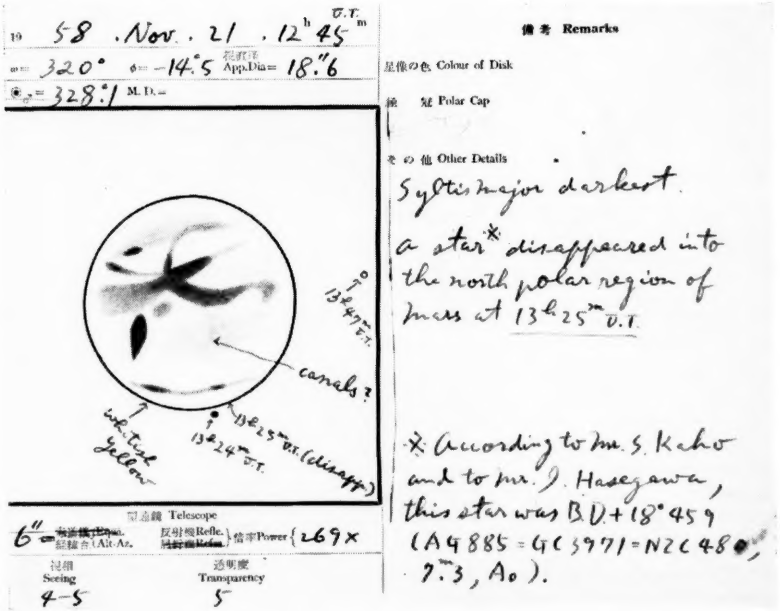
Mars' orbit causes unequal seasons and its long year also brings longer seasons. Observations at aphelic oppositions are important, because at this time the northern hemisphere and northern polar cap are most favorably presented, while at perihelic oppositions (the next is in 1971) the southern hemisphere and pole cap are favorably placed and larger in apparent size. Because of this, our information on Martian surface markings is top-heavy in favor of the southern hemisphere.

In a recent communication, Walter H. Haas, director of the Association of Lunar and Planetary Observers, points out that this is the most favorable opposition for northern hemisphere observations since 1952, and suggests that observers pay attention to such north-latitude surface markings as the Nubis Lacus (Martian longitude 255°, latitude 25° N.). He also suggests that there may be small but prominent whitish clouds in the northern climes.

A yellow clouding often occurs before opposition, obscuring large sections of the Martian surface. This apparently is caused by dust or sand storms on the surface of the planet. A clearing usually comes about near the time of opposition, however, although some Martian apparitions are somewhat dimmed throughout by yellow clouding, and clearing never completely occurs.

The surface features of Mars may be located with the aid of the chart on page 19. Haas warns against familiarizing oneself with a map of Mars and then attempting to identify markings by mere comparison.

(Continued on page 34)



19 58 . Nov . 21 . 12h 45m U.T.

ω = 320° φ = −14.5 App.Dia = 18.″6

⊙ = 328.1 M.D. =

備考 Remarks

星像の色 Colour of Disk

極冠 Polar Cap

その他 Other Details

Syrtis major darkest.

a star* disappeared into the north polar region of Mars at 13h 25m U.T.

canals?

whitish yellow

13h 47m U.T.

13h 25m U.T. (disapp.)

13h 24m U.T.

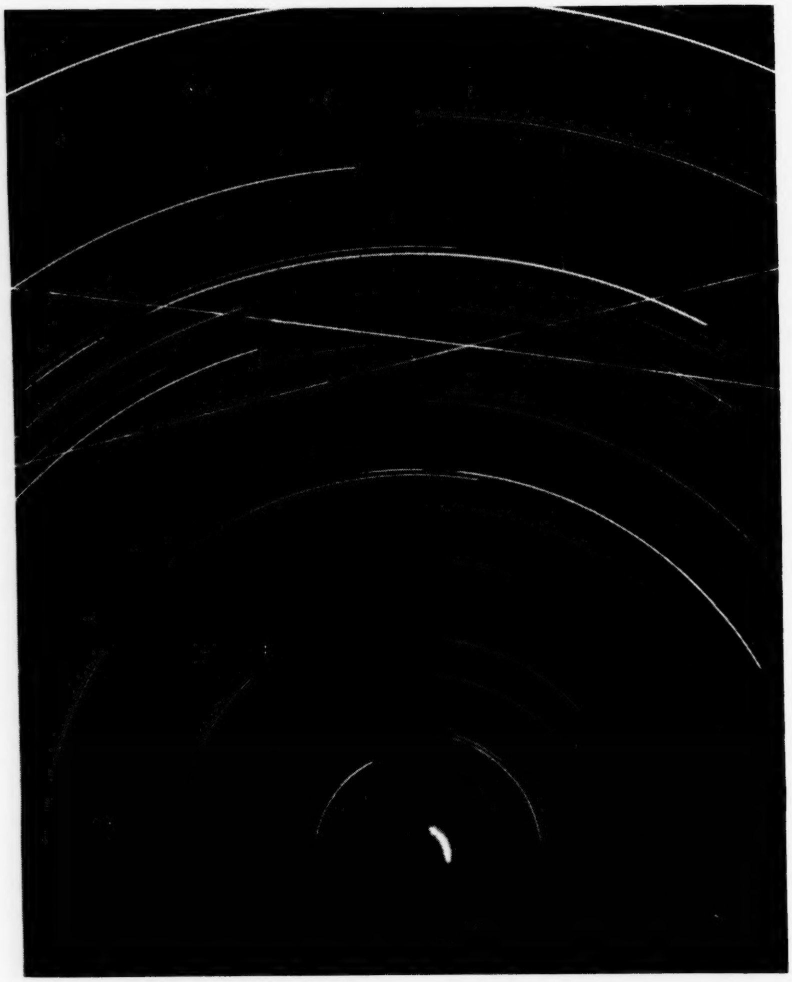
* According to Mr. S. Kaho and to Mr. J. Hasegawa, this star was B.D.+18°459 (AG885 = GC5971 = N2C480, 7.3, A0).

望遠鏡 Telescope 6″ 反射鏡 Refle. 経緯台 (Alt.Az.) 倍率 Power {269x

視相 Seeing 4-5

透明度 Transparency 5

Page from observing notebook of Takeshi Sato, Oriental Astronomical Association observer, shows what can be done with a 6" reflector. Courtesy of Walter H. Haas, ALPO.



Satellite Echo I photographed from O'Fallon, Missouri on two successive passages on August 21-22 at 11 p.m. and 1 a.m. CDT. The camera, an Exakta VX IIa with a 50mm f/1.9 Xenon lens was loaded with Tri-X film and was set on "time" at full aperture at 10:15 p.m. and closed five hours later at 3:15 a.m. The bright star trail in the lower center is Polaris, the pole star. In the picture south is at the top, east to the right and west to the left. In reference to Polaris it can be seen that the orbit of the satellite is changing orientation as the rotation of the earth affects the observer's position. The upper trail at the left side is the first passage at 11 p.m., which began in the southwest portion of the sky, its termination being in the northeast sector. The lower passage at 1 a.m. passed from the west to the east-northeast. Both images show variations in brightness in the satellite. A later passage, seen through broken clouds, was traveling from northwest to southwest. Occasional light clouds late in the exposure caused the star trails to become broken. To the lower right of Polaris a meteor trail can be seen. All photographs, unless otherwise indicated, are by the author.

SATELLITE - CATCHING BY CAMERA

Robert E. Cox
McDonnell Aircraft Corporation

A capsule from Discoverer XIV satellite has recently been plucked from the air by United States aircraft, a feat the amateur can never hope to equal. However, any amateur can "catch a satellite" with modest equipment—a reasonably fast camera capable of bulb or time exposures. With satellites as brilliant as Echo I, even a camera of f/4.5 combined with fast modern films and special high-energy developers can register the passage of a man-made baby moon. The pictures included with this article show several possible methods of making this record, including short or extremely long exposures to obtain special effects.

In ordinary, everyday photography the speed or f-number is all-important in recording faintly lit scenes; however, in photographing stars it is only the linear diameter of the lens that is of paramount importance. In the first case we are photographing areas, but with the stars we find they are points of light, even in the world's largest "camera," the 200-inch Hale reflector on Palomar Mountain.

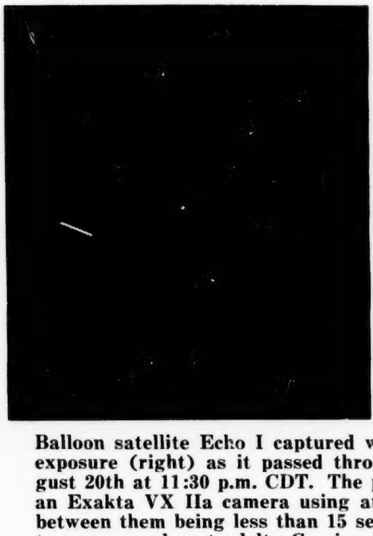
This dependence on aperture is especially true when we deal with relatively short exposures of a few minutes. For example, if two lenses of 1-inch diameter, but one having twice the focal length of the other, are exposed on the same star field for five minutes, they will both have recorded the same limiting magnitude or faint star. If celestial objects with extended surfaces are to be photographed, such as the moon, planets or nebulae, then once again the relative speed of the lenses is important. However, in satellite photography we are concerned only with recording a point image, so relative speed can be ignored.

The focal length of a suitable camera lens for satellite-catching is important, because short-focus fast lenses on miniature type equipment have lenses 1-inch or greater in diameter, but the film scale crowds the images together and makes extreme enlargements (with resulting grain problems) necessary in order to separate close stellar images. It is not generally advisable to use a lens with a shorter focal length than the standard 50-mm usually found on such cameras. Such a lens, if it has a speed of f/2, will yield a satisfactory 1-inch aperture lens. Actually, the lens on a 4 x 5 press-type camera, f/4.7 with a 135-mm focal length, will have a slightly greater clear aperture (about $1\frac{1}{8}$ inches) and be slightly superior in registering faint star images with short exposures. However, most amateurs have roll film cameras, the average size of the lens being up to about one inch, and with the film size $3\frac{1}{4}''$ in its largest dimension.

This Echo I photo, sent in by reader Lee Born of Topeka, Kansas, shows the balloon satellite rising up from the western horizon through the equatorial stars of Ophiuchus and Serpens, then quickly disappearing (at left) as it is extinguished by the earth's shadow. Satellite was photographed on Sept. 12th, and entered the shadow at 10:02 p.m. Born used a Wollensak Raptar telephoto lens working at f/5.6, exposure being made on Royal Pan.

What film is the most desirable? If you are attempting to reach the faintest possible magnitude during the exposure, then the fastest film on the market which fits the camera should be used. The films generally used are Tri-X, Super Hypan, Agfa Isopan Record, Isopan-Ultra, Ilford HPS, and as a special case, Royal-X Pan. Except for the last one listed these films are developed in fine-grain, high-energy developers for the maximum time suggested by the manufacturer. In the case of Royal-X Pan, you should use only the recommended commercial developer listed in the information sheet enclosed with the film, otherwise poor negatives will result.

For the other fast films listed above, almost any high-energy, fine-grain solution will do; however the writer has had extremely good luck with Ethol UFG developer in work of this kind. Those amateurs with photographic experience will probably wish to try various experiments to determine for themselves how to achieve the best results.



Balloon satellite Echo I captured with a 10-second (left) and a 1-minute exposure (right) as it passed through Cassiopeia on the evening of August 20th at 11:30 p.m. CDT. The pictures were taken on Tri-X film with an Exakta VX IIa camera using an f/1.9 Xenon 50mm lens, the interval between them being less than 15 seconds. The path in the right hand picture passes close to delta Cassiopeia as it descends into the northeastern sky. Note the increased number of stars in this exposure, six times as long as the left-hand one, but with a greater elongation of the faint star images due to diurnal motion.

Films exposed for satellite trails *can* be sent to commercial processing plants, but some loss of limiting magnitude will be encountered. Invariably, there will be the processor who, believing the film to be blank or improperly exposed, will fail to print the negatives. It is suggested that a special note be included with such films informing the processor of the nature of the negatives and requesting that he please print them to the best of his ability. If possible, the amateur should process his own film, or arrange for some friend who does his own developing to process them.

How long should an exposure be in order to include a record of a satellite from one end of the film to the other (on the long dimension)? If Echo I is the subject it will be covering about 8° per minute at its 1,000-mile altitude, so a 7-minute exposure should be adequate. It is suggested that the camera be placed on "time" just before the satellite enters the camera field, as this will prevent any vibration from disturbing the image. In the 7-minute exposure period the stars will trail—because of diurnal motion—almost 2°, making their trails only a small fraction of the satellites. For example, if the camera covers a field of 48° on its longest dimension, the stars will be less than 1/24th the length of the film—for a film length of $3\frac{1}{4}''$ they will be approximately $\frac{1}{8}''$ long. If you wish to record the stars as points (or almost point images) and use less than a 1-minute

exposure, the film will at first appear to be empty except for the satellite trail; however, careful examination will show the star images and with care they can be printed.

A firm support should be provided for the camera; if available, a sturdy tripod can be used. However, with care a table or any strong stable flat surface will suffice. A cable release to trip and close the shutter is a valuable accessory and will help to prevent movement of the camera. Pictures such as we are planning are of little value if the camera moves or vibrates during the exposure. It is also necessary to keep the lens covered until just before exposing in order to prevent dew from settling on it. This is a problem in cool, humid climates, and such a deposit of dew has the effect of lowering the film speed and preventing the subject from registering. A dim light can be used before exposure to see if dew has condensed on the lens. However, if it has, do not attempt to wipe it off with a cloth, for the coating on the lens may become damaged. The only safe thing to do in this case is to close up shop for the evening and take the camera indoors and allow the dew to evaporate. Many a night of star photography has abruptly ended by a heavy deposit of moisture that a dew-cap is unable to prevent.

It is possible to expose for a 2-hour period or longer and register the passage of a satellite twice on the same film. However, if you are located in a city or near bright lights, the sky illumination in the surrounding atmosphere will cause the film to become fogged and difficult to print. A 5-hour exposure of the circumpolar area by the author recorded two passages of the Echo I satellite (the third failed by a small margin to pass through the field), but the negative is heavy with sky fog and difficult to print. It is suggested that the amateur take simple star trail pictures from his locality and determine its limiting exposure.

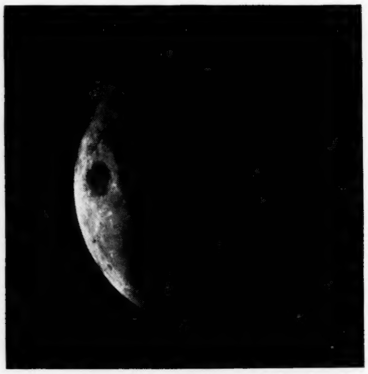
Upon development it will be found that, although the satellite appeared as bright or brighter than the stars in the field, its image is not as intense, apparently indicating it wasn't as bright as viewed. This is not true, of course, as the effect is caused by the rapid movement of the satellite through the field. The stars, moving only about 1/32nd as far as the satellite, had a longer time to register on the film and as a consequence have more density. Satellites do not "sit" for their portrait, but, like a track star, race across the sky giving a weak image. It is this rapid motion that makes registering the image difficult on slow cameras or with slow films.

Brightness changes will be registered as knots in the satellite trail, and in some instances it may fade out altogether. Fluctuations of this nature are most interesting and if, at the time of exposure, an observer is making naked-eye estimates of brightness and the period of fluctuation, a valuable record will have been made. If there is a Moonwatch station in your vicinity, such films and records should be brought to the attention of its director.

With a fixed camera the satellite trail will be a straight line on the film, but in actuality the path is a curve, a great circle passing around the earth. If the camera is placed on an equatorial mounting, which enables it to follow the stars during an exposure so their images do not trail but appear as small points, then the track of the satellite will be curved, showing this true path.

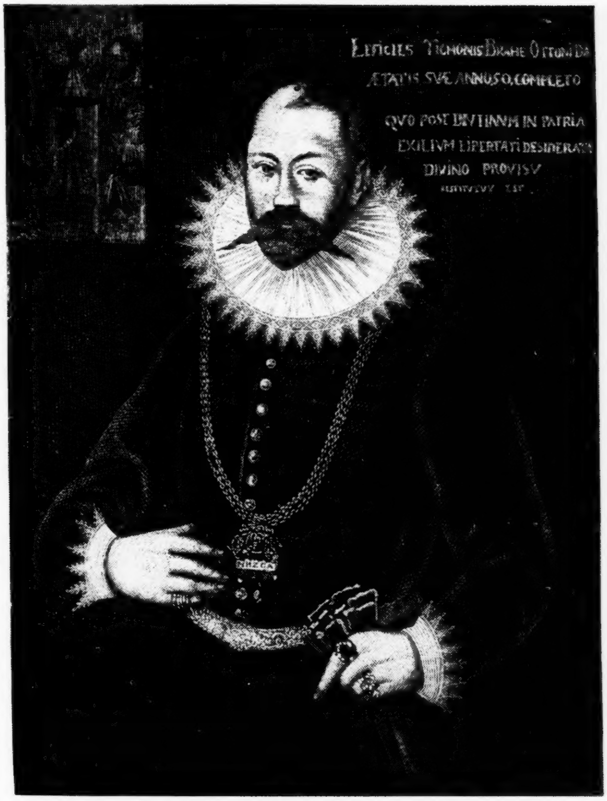
If a nightly record is made of satellite passages, then a comparison of the films will reveal the shifting position of its path among the stars as it appears earlier each evening.

Two negatives of Echo I passing through Cassiopeia superimposed to show the change in its track (left to right) over an interval of four days. The bottom trail was made under excellent sky conditions on August 20th shortly after 11:30 p.m., CDT, while the upper path was made in a poor sky with a strong haze on the evening of August 24th shortly after 9:50 p.m. Both exposures are of one minute duration, using the same film and camera as the other pictures shown on these pages. The bottom passage is near to delta Cassiopeia, but the other one is between beta and alpha in this well-known circumpolar constellation.



These three photographs of the total eclipse of the moon on Sept. 5, 1960, were made by J. Russell Smith of the Skyview Observatory, Eagle Pass, Texas. Mr. Smith, a science instructor and amateur astronomer, uses a 16-inch f/5.5 Newtonian reflector in his photographic work, and increases the size of the lunar image with a 2x Barlow lens. Roundness of earth's shadow on moon was minimized in effort to print out exquisite detail of sunlit portion of moon. (Left) shows moon just after first contact, (center) half-way between first contact and totality, (right) shortly before beginning of total phase.

This portrait of 16th century astronomer Tycho Brahe (from an old woodcut) shows the Danish nobleman at his most distinguished—including his artificial gold-and-silver nose.



THE ECLIPSE THAT CHANGED THE COURSE OF ASTRONOMY

BY ARMAND N. SPITZ

OCTOBER 21, 1960, WAS THE 400TH anniversary of an eclipse of the sun which, to an extraordinary degree, changed the entire course of astronomical research and achievement—the eclipse that made Tycho Brahe an astronomer.

Tycho Brahe belonged to a noble family of Denmark. His father had filled a number of important positions in the Danish government and was ultimately made governor of Helsingborg Castle. Tycho was born in 1546—and into rather unusual circumstances. The soon-to-be-born Tycho's Uncle George was childless and wanted to adopt a son to whom he could leave his wealth and give his educational and moral support. Before Tycho's birth his parents had agreed that Uncle George might bring up their first son. But, when Tycho was actually born they changed their mind, and it was not until a second son was born a year later that Uncle George took what he regarded to be the necessary action to keep the compact. He simply stole his firstborn nephew in accordance with the agreement which had earlier been reached. Before very long, Tycho's parents recognized that perhaps their elder son was better off, and it was in Uncle George's home that the future astronomer was educated.

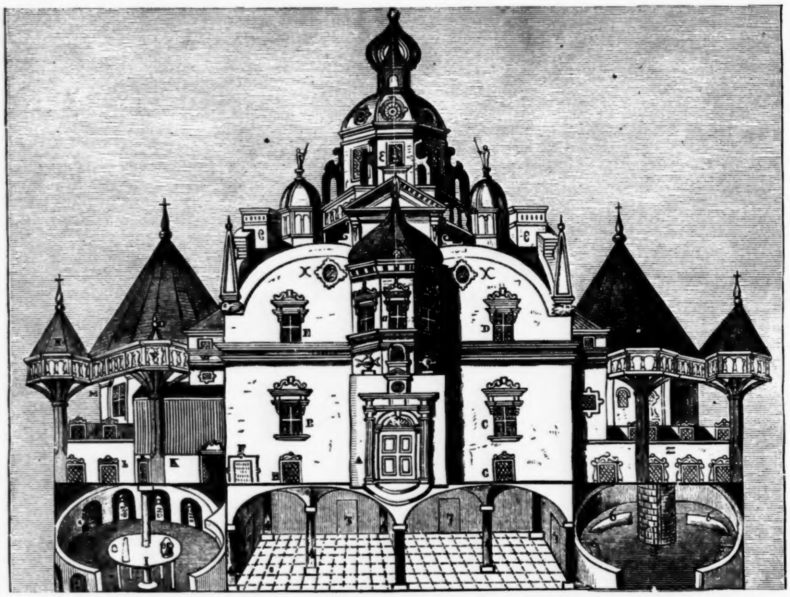
When he was 13 years old, Tycho Brahe entered the University of Copenhagen. Education in those days was far more elementary than today. By the same token, today's elementary and secondary school education is far more sophisticated than any that had ever been thought of up to the present time.

Tycho's uncle intended that he plan to become a stateman in accordance with his noble birth. There were few other professional opportunities normally available to nobility. Consequently, Tycho's curriculum at the university included rhetoric and philosophy and similar subjects which might be appropriate to the diplomatic service.

However, the eclipse of the sun of October 21, 1560, completely changed the course of Tycho's planning. It might well be said that seldom has an eclipse of the sun had such "total" and far-reaching results. It could only be partially seen at Copenhagen. His astonishment in connection with the eclipse stemmed from the fact that the time of the beginning, the middle and the end of the eclipse could be predicted with so much accuracy. In an effort to understand this more thoroughly, he switched his attention to mathematics, physics and particularly the motions of heavenly objects.

It was difficult for young Tycho to find books that would be helpful. It must be kept in mind that this was long before the days of telescopes, or of Kepler or Copernicus, whose work had such a profound influence on the ultimate development of our understanding of the universe. Just a short time before this eclipse, however, a Latin edition of Ptolemy's astronomicala works had been published, and Tycho bought this and studied it while he was still at the university. His uncle thought that it might be better to complete his education by taking him away from the University of Copenhagen and sending him to a foreign university, perhaps in the hope that in this way the attention of Tycho might be directed more to national service than to a study of the stars. So, in 1562 he went to the University of Leipzig.

Even this did not make Tycho adopt an interest in law or philoso-



"Uraniborg," Tycho's observatory on the Danish island of Hveen. He carried on his observations, made with many accurate but non-optical instruments, for 21 years, and built another observatory for his extensive staff. When support of Danish royal house faded, Tycho took instruments to Prague, where he passed away a few years later. ("Stargazing," Ball.)

phy. The stars and other heavenly objects were his sole concern. It has been recorded that he spent all of the pocket money which his uncle would allow him, and any more that he could get, in secretly buying astronomical books and instruments. Many of his studies had to be done when no one could see him, because he was afraid that his equipment would be taken away.

When he was only 17 he began to compute the movements of the planets against the background of the stars from night to night. He noted that the positions of the planets did not agree closely with some of the calculations which had been produced by earlier astronomers. He therefore decided that the only way to study this matter was to make a series of extremely accurate measurements of the position of the planets and the stars over a long period of time. No one had ever approached an understanding of the heavens in this way before, but Tycho was a true pioneer.

The first instrument that he used was a simple pair of dividers. He placed his eye at the hinge and pointed one leg to each of two stars, and then brought the dividers down to a carefully calibrated circle so that he could determine the number of degrees between the stars. This was the first time measurements like this had been made systematically. Since this was decades before the invention of the telescope and there were no optical aids to observation, it was necessary to rely entirely on mechanical and geometrical systems to make accurate measurements. The cross-staff was a very ancient instrument, which had largely been used for laying out angles on the ground. However, Tycho learned to use it with a great deal of accuracy and began to gain a better understanding of some of the principles which underlie modern astronomy. He continued to use improved measuring instruments, which became larger and larger, and more and more accurate.

On October 28, 1566, there was an eclipse of the moon. Like every other astronomer of those days, Tycho had always had some feelings that astronomy and astrology were closely related. He wrote some verses on the wall at the University of Rostock where he was then working, which proclaimed that the approaching lunar eclipse would foretell the death of the great Turkish Sultan. Not long later, news did arrive of the death of the Sultan and for a period of time Tycho was triumphant, but later it developed that the Sultan had died before the eclipse and Tycho was for a while the target of a good many jokes.

During the time that he was at the University of Rostock he had a serious argument with another Danish nobleman who was a student there. There had been some stories that this was over an affair of the heart, but it appears to have had no more romantic origin than a difference of opinion as to which of them knew more about mathematics. It came to an honorable end when a piece of Tycho's nose was sliced off by his opponent's sword. For the rest of his life, Tycho Brahe wore a combination gold and silver artificial nose.

Another major event which stimulated his astronomical work occurred on November 11, 1572, when he looked at the sky on his way home and saw a brilliant star which he had never seen before in the constellation of Cassiopeia. He found it hard to believe that he was seeing correctly. Feeling that he must be the subject of some hallucination, he called the servants who were accompanying him and asked them whether they, too, could see a brilliant object there. He assumed that this meant that there was a brand new celestial body which had suddenly burst forth. This was before the concept of novae, or new stars, was recognized. Tycho measured its position very accurately and attempted to make measurements of its distance. The star was so extremely bright that he thought it was much closer than the stars in the same portion of the sky. He felt that it might be possible to measure its distance by making very accurate determinations of its position from the surrounding stars. He made repeated parallactic observations at 12-hour intervals, made possible because the star was bright enough to be seen in full daylight. The results were negative, but he demonstrated that the object was so far away that the diameter of the earth did not affect its apparent position against the background of the stars. Some other observers had considered that the new star was as near as the moon, or perhaps even closer.

However, "Tycho's star," as it has come to be known, showed no proper motion in the heavens and, therefore, was too great a distance for measurement. He recorded the changes in its brightness from week to week, as well as the changes in hue which were apparent. One of the interesting theories advanced in connection with Tycho's star is that it might have been regarded as the star of Bethlehem an-

nouncing the birth of Christ. (See page 4). Tycho's papers on the observations of this star were his first published document. Many people thought he should not write a book because, after all, he was a nobleman and it was beneath the dignity of a nobleman to do any such thing.

He determined to risk the adverse judgment of his peers, and his book was the first of a series of great works resulting from his research.

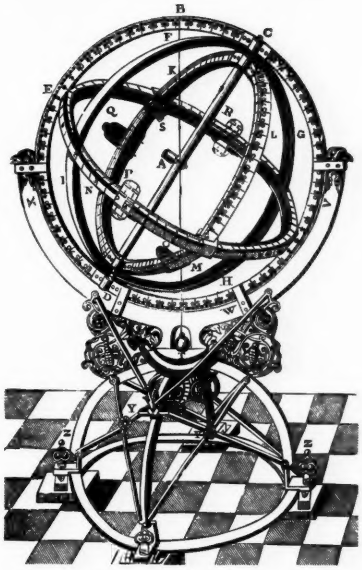
The fame of Tycho by now had spread throughout the world, and the King of Denmark begged him to return to his native country and give a series of lectures on astronomy in the University of Copenhagen. His introductory oration when he returned to Copenhagen covered the tremendous universal interest and beauty of phenomena that take place in the heavens and the absolute necessity of continuous and systematic study of the heavenly bodies in order to extend our knowledge. He called attention to the practical utility of astronomy in terms of the measuring of time, and told how astronomy "exalts the mind from earthly and trivial things to heavenly ones."

Many of Tycho's friends in Germany wanted him to return to that country to continue his work. However, the King of Denmark, Frederick II, realized that it would be desirable to persuade Tycho to remain in Denmark and finish his life work in astronomy. A courier was sent to Tycho and was ordered to travel day and night until he reached Tycho, whom he was to bring to the King. Tycho was in bed on the morning of the 11th of February, 1576, when this message was delivered, but he set off immediately and told the King of Denmark that what he needed was the means to pursue his astronomical studies unmolested. The king, accordingly, offered him the beautiful island of Hveen, near Elsinore, which would give him all the seclusion that he wanted, and he was given the funds for building a home and the finest observatory that had yet been constructed for studying the stars.

On the island of Hveen the famous Castle Observatory of Uraniborg was built, and the foundation was laid on the 30th of August, 1576. Some of the most remarkable astronomical instruments that had ever been built were installed at Uraniborg. He had a staff of assistants and built another observatory for their use, including some instruments in underground rooms. At this observatory, which many people regard as the first truly scientific observatory in history, Tycho's work consisted largely in the precise determination of the places of the moon, the planets and the stars on the celestial sphere, and his extremely accurate observations were used for the scientific conclusions later reached by Kepler and others.

He is remembered as the last of the great pre-telescopic astronomers, as the most accurate observer in history up to that time, and as the author of a relatively unimportant but interesting theory which attempted to explain the apparent motions of the heavenly bodies. Throughout his entire lifetime, Tycho declined to accept the Copernican theory that the sun was the center of the entire universe. Instead, he offered the Tychonic idea that the planets, all except the earth, all move around the sun. However, the sun moves around the earth with all the other planets. Peculiarly enough, despite the fact that Tycho's idea for the mechanical structure of the terrestrial system is wrong, it explained most of the observed phenomena.

With all of his dedication to astronomy, Tycho's personality led him to difficulties which appeared to increase with his advancing years.



Equatorial armillary, or astrolabe, made by Tycho Brahe for his observatory. (From "Stargazing".)

When young King Frederick was crowned in 1596, the new monarch reversed the policy of his predecessor and took Hveen away from Tycho. One by one, Tycho's pensions were withdrawn, and finally Tycho went to Czechoslovakia, then Bohemia, where he died in 1601.

Haverford College Photo

Strawbridge Observatory at Haverford College, site of League Convention

League Convention at Haverford College

DESPITE THE RIGORS placed upon many of the delegates by the Pennsylvania Railroad strike, more than 300 representatives of astronomical societies from all parts of the United States and Canada attended the 1960 Astronomical League Convention at Haverford College, Haverford, Pa., Sept. 3-5. The charming setting of the old Quaker college, which is located in a nearby suburb of Philadelphia, was an ideal environment for the three-day meeting.

Hosts for the Haverford Convention were the Rittenhouse Astronomical Society and the Amateur Astronomers of the Franklin Institute, both Philadelphia organizations. General chairman was Edwin Bailey of the Franklin Institute staff, who was ably assisted by volunteer workers from both of the local societies.

Saturday's activities began with a general business meeting, followed by an afternoon paper session presided over by James Conklin, president of the Rittenhouse Astronomical Society. Included among the papers were "A Review of Roemer's Method for the Calculation of the Velocity of Light," Dan Kinglesmith, Jr.; "The Elliptical Orbit," C. M. Billings; "The University of Illinois Radio Telescope," L. C. Zillman; "Wind, Sand and Stars" (Balloon Astronomy), E. T. Vadala; and "Polynesian Astronomical Ideas," Dr. Earle G. Linsley.

Following this general session, Tim Wyngaard, co-chairman of the League's Junior Activities section, led a junior session marked by an impressive array of reports and papers. Among these were "A Caster Cup Telescope," Robert Kenison (a delightful "reminiscence in tranquillity" of a young amateur's labors in making his first telescope); "A Proposed Classification System for Deep-Sky Objects," George Doschek and Jim Mullaney; "Some Human Factors in Astronomy," Minick Rushton; "Activities of the Northeast Region Juniors," Charles Downton, Jr.; and "An Amateur Views a Professional Eclipse Expedition," Tim Wyngaard. Wyngaard was sent by the Astronomical League to assist a group of professional astronomers on an expedition to observe the total solar eclipse of Oct. 2, 1959, from the Canary Islands.

Saturday evening was spent in visiting several observatories in the area. Many remained on campus to view Saturn and Jupiter through the 10-inch Clark refractor of Haverford College's Strawbridge Observatory, while others drove to the nearby Villanova Observatory. A small group of amateurs especially interested in photoelectric photometry gathered for a demonstration of the equipment at the University of Pennsylvania's Flower and Cook Observatory under the guidance of Dr. Frank B. Wood, a specialist in this field. Weather was favorable for all, in spite of a nearly full moon, and an added fillip to the evening's observing was the overhead passage of Echo I.

Sunday was spent in a bus tour to points of astronomical interest in the Philadelphia area, including the Fels Planetarium of the Franklin Institute, the Edmund Scientific Co. in Barrington, N. J., the Spitz Laboratories in Yorklyn, Del., and the Sproul Observatory at Swarthmore College. Touring amateurs were given a special lecture and demonstration at the Fels Planetarium, after which they

gathered at the rooftop observatory of the Franklin Institute for a view of solar prominences through the 10-inch Zeiss refractor. The visit to the Edmund Scientific Co. enabled the delegates to enjoy both a steak dinner and the opportunity to spend some time (and some money) among the "astronomical smorgasbord" of the Edmund retail store. The firm's entire staff was on hand to answer questions, guide the visitors through the establishment, and to facilitate the orders, purchases and inquiries of the delegates.

The bus tour then moved on to Spitz Laboratories for a brief but impressive showing of the Laboratories' new planetarium projectors. After an inspection of the projector assembly area, the conventioneers were taken to a nearby hilltop club for an outdoor buffet supper. Personal hosts for the event were Mr. and Mrs. Armand N. Spitz, assisted by officials of the Laboratories. The trip was topped off that evening by a visit to the Sproul Observatory of Swarthmore College in suburban Philadelphia, where the 24-inch Brashear refractor, famous for its use in the determination of stellar distances, was made available to the delegates. Cloudy skies hampered observations, however.

Monday saw a resumption of paper sessions, the first by members of the Association of Lunar and Planetary Observers, which held its eastern meeting in conjunction with the League Convention. Walter Haas, director of the Association and editor of THE STROLLING ASTRONOMER, the ALPO journal, presided at this morning session. Papers included "The Rills near Plana and Burg," Leonard Abbey, Jr.; "The Lunar Meteor Project and the Future," Robert M. Adams; "Amateur Observations of Saturn," Phillip W. Budine; "The Future of the ALPO Mercury Section," Geoffrey Gaherty, Jr.; "An ALPO Venus Month," William K. Hartmann; "Some Informal Remarks about Jupiter," Philip R. Glaser; "Possible Effects of Comets on Starlight," David Meisel; "On the Variation of the Phase of Venus from Theory," Minick Rushton; "Amateur Research," William E. Shawcross; "An Appeal for Tolerance of Unorthodox Thinking," Eugene Spiess; "The Lunar Training Program of the RASC Montreal Centre," George Wedge; and "An Outlook on the Nature of Comets," Francisco Lugo.

The Monday afternoon session, covering the design and construction on astronomical instruments, was chaired by George Keene, of Rochester, N. Y. Papers and demonstrations included "A Home-Made 16-inch Telescope," Emil Klein; "The Deceptive Allure of Making a Maksutov," Gilroy Roberts; "Alignment Proce-

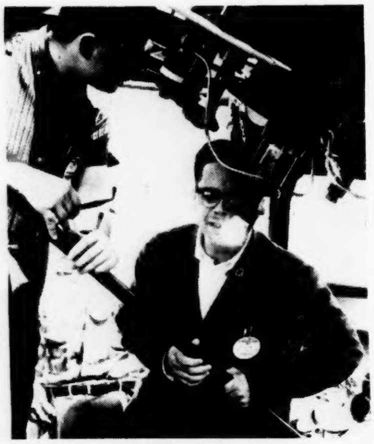
Hungry delegates line up for steak dinner at Edmund Scientific Co. Amateurs toured plant and visited Edmund retail store. Short-order cook at right is Norman Edmund.

Convention chairman Ed Bailey, a bit worn but still loquacious, discusses a technical point with Gil Stitely (right) of Spitz Lab staff.

League members leave test dome at Spitz Laboratories after a demonstration of firm's new projectors. Viewers were impressed by realistic new star field previewed during brief show, also had opportunity to visit planetarium works afterward.

dure for a Newtonian Telescope," Ralph Dakin; "A Null Test for Paraboloids," Charles Spoelhof; "A Planetarium for the Lehigh Valley," Ralph Schlegel; "Lenses for Astrophotography," Dr. Henry E. Paul; and "A New Corrector for Astigmatism," Joseph C. Eyer. Additional examples of amateur and professional instruments were on display during the Convention.

A League business session and a special business session of the Middle East Region completed the day's meetings. On Monday evening the Convention banquet was held in the Haverford College dining hall. The ALPO award was presented by Walter Haas to David Meisel, recorder of the ALPO comet section, for his work in reviving and organizing amateur work in the field of comet astronomy. Featured speaker was Dr. Louis C. Green, director of the Strawbridge Observatory. His subject, officially titled "Rockets, Satellites and the New Astronomy," proved to be a fast-moving journey to the frontiers of space-age astronomy and its problems. Among the "visual aids" used by Dr. Green in his quick-paced and penetrating review were the guests at the speakers' table, whom he used to demonstrate the range of the visual and radio spectrum, and the convenient head of general chairman Ed Bailey, which the Haverford astronomer repeatedly found useful in demonstrating terrestrial and solar relationships!



George Doschek (right) views sun's disc through solar eyepiece of Zeiss refractor at Franklin Institute while Jim Mullaney observes prominences through monochromator.

Retiring as president of the Astronomical League was Chandler H. Holton, of Atlanta, Ga. The new president is Norman C. Dalke of Seattle, Wash. Other new officers include Ralph Dakin, Rochester, N. Y., vice-president, and Dr. Herman Sehested, Ft. Worth, Texas, secretary. Leonard Pardue, Miami, Fla., was re-elected as treasurer.

Copies of the *Proceedings* of the 1960 Astronomical League, which contain the complete texts of all papers presented at the meetings, are available from Edwin Bailey, The Franklin Institute, Philadelphia 34, Pa. Estimated price was $3.00.

It was announced that the 1961 League Convention will be held in Detroit, Michigan, with the Detroit Astronomical Society as host. Further details on this Convention will be given in later issues of the SKY MAP. D.D.Z.

YOUR TELESCOPE AND MINE

Chart at right was compiled by Mars Recorder Frank Vaughn of the ALPO from observations made during Mars' opposition in 1958-59. Observers may use this map in identifying main features of Martian surface in 1960-61.

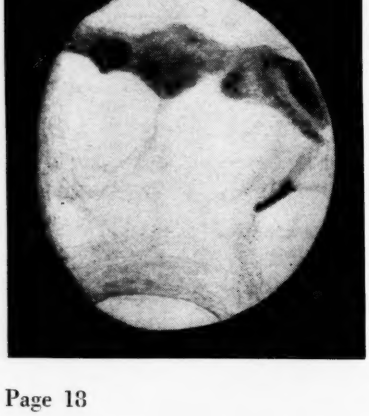
OBSERVING MARS IN SMALL TELESCOPES

By Thomas R. Cave

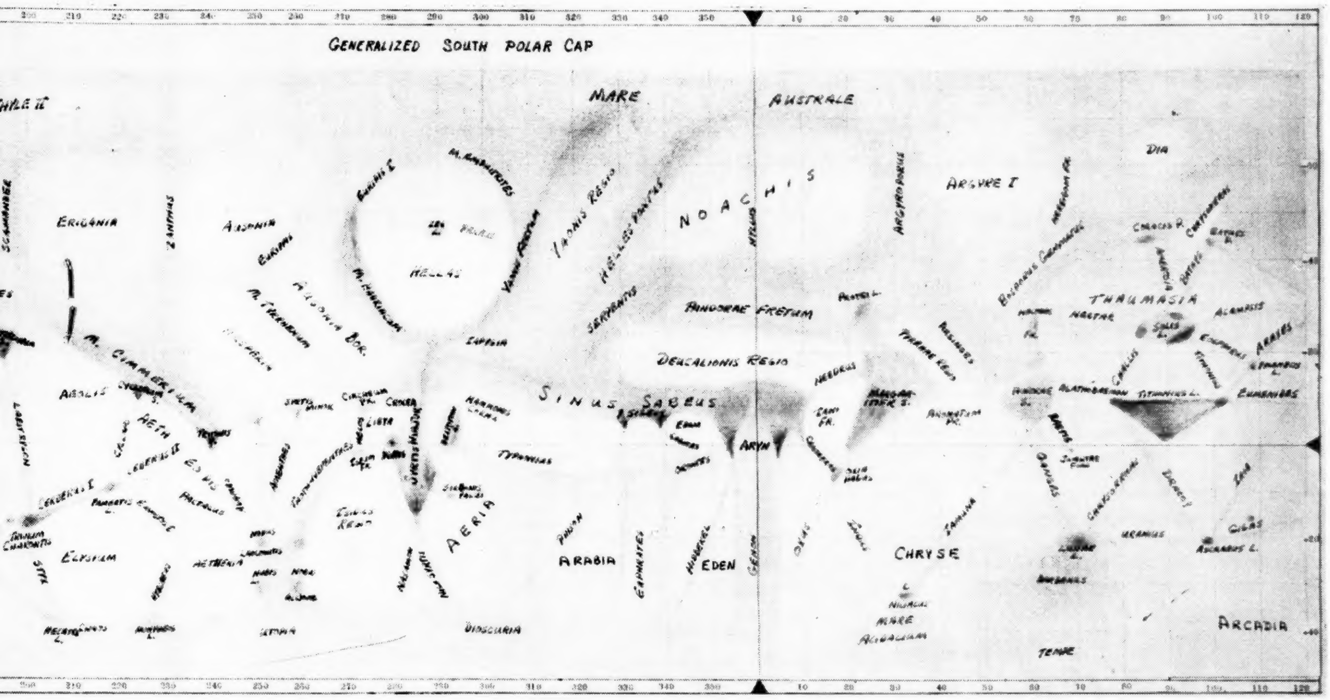
More than any other celestial object, the planet Mars has always excited the imagination of the beginning observer. Every two years and two months Mars and the earth reach positions in their orbits so as to form a straight line in respect to the sun. These orbital alignments are called oppositions (opposite the sun from the earth). The earth travels in a nearly circular orbit about the sun, but the path of Mars is much more elliptical; so the distance separating the earth and Mars may vary considerably at different oppositions, from about 35,000,000 miles to as much as 63,000,000 miles. Mars is only slightly more than half the diameter of the earth and its apparent size, even at its most favorable approaches, is never large. Actually, the disc of Mars varies from as large as 25″ of arc at most favorable oppositions to only 13″ at least favorable oppositions. For telescopic observers in the earth's northern hemisphere, the closest approaches of Mars occur during late August are early Septmeber when, unfortunately, the planet is far south of the celestial equator. In like manner, when the planet is highest in our northern skies it is most distant, these oppositions occurring in February or March.

This winter, Mars will be closest to the earth on Christmas night, when its apparent diameter is 15″.4 of arc, a bit below its mean oppositional size. The term *opposition* actually refers only to the exact time when the sun, earth and Mars form a straight line in space; however, Mars can be effectively observed in a telescope for a period of months both before and after opposition. Most experienced telescopic observers of Mars believe that the planet can best be studied only when its disc is at least 10″ of arc or larger in size. Thus, the period of observations is much longer at a close apparition of Mars than at other more distant apparitions. These very close approaches are termed *perihelic oppositions*, and those occurring when Mars is at the farthest oppositional distance are termed *aphelic oppositions.*

Most beginners are quite disappointed by their first views of Mars in any telescope, large or small. Also a number of texts and popular books on astronomy lead the novice to believe that only large telescopes



(Left) Drawing of Mars made on Oct. 4 by Clark R. Chapman of Buffalo, N. Y., using a 10-inch reflector. Martian longitude 163° is on meridian; see map. Planet shows gibbous phase before and after opposition. (Right) Drawing by Chapman on Sept. 19, with 255° on meridian.



located in the world's most desirable "seeing" regions are capable of giving good views of Mars. Such statements are quite untrue, and they probably have discouraged many from attempting serious observational study of Mars with their telescopes. To prove the amount of fine detail that can be seen on Mars with telescopes of ordinary aperture, one needs only to examine the enormous amount of excellent observational work that has been accomplished since 1890 by the Mars Section of the British Astronomical Association. Equally fine work has been done more recently by observing members of the ALPO in America. A very large part of all serious amateur study of Mars has been done with modest apertures — 8 inches and smaller.

The telescope usually found in the hands of the beginner is either a refractor of from 2½ to 4 inches in aperture or a 4 to 8-inch reflector. While a rather large telescope may frequently render disappointing views of Mars, a small refractor or reflector of good quality will often reveal far more detail than the beginner might expect, and such an instrument will nearly always give a pretty good account of its maximum resolution. There are several factors which usually cause indifferent performance of the large telescope, the

Drawings of Martian surface markings during 1958 apparition with his 8-inch reflector. (Top, left) Sept. 29, 1958, 0°: Sinus Sabaeus and Margaritifer Sinus prominent. (Top, right) Oct. 8, 1958, 274°: Syrtis Major and Thoth-Nepenthes. (Bottom, left) Oct. 13, 1958, 210°: Canal complex visible north of Sirenum-Cimmerium. (Bottom, right) Oct. 20, 1958, 145°: south polar cap has grown smaller. South at top in all drawings.

major cause being the unsteadiness of the earth's atmosphere, or bad seeing. When frequent bad seeing plagues large instruments, a small scope often suffers relatively little, and far less frequently, from this effect. Also, large reflectors suffer more from temperature differentials between the mirror, tube and the surrounding air than do small instruments; and the optics of many large telescopes probably never reach equilibrium with the air during an entire night of observing. This condition often occurs only in the early morning hours, when many hours of good observing time have been lost.

These factors alone can easily account for the reason that really large telescopes are usually less effective for the visual study of Mars than smaller apertures. The late Mars observer W. H. Pickering long ago suggested an aperture of 15″ to 20″ as optimum for the most advanced visual work on Mars and the other planets. Even smaller apertures were advocated by the great French planetary observer, M. Jarry-Desloges, who suggests a very long-focus (f/30) refractor of 8¾ to 9¼ inch aperture or a 12¼ to 13¾ inch aperture of similar focal ratio as being ideal for the serious study of Mars.

Just how much a beginning observer will be able to see on the small disc of Mars is largely up to him. If he has a small refractor or reflector, he can see, under good conditions, not only the polar caps of Mars but all of the main dark *maria* visible during the coming 1960-1961 apparition. It should be remembered that the first usable map of Mars was made in 1830 by Beer and Madler, using a 3¾ inch refractor hardly perfect by today's optical standards. This map certainly showed all the major dark *maria* of the planet easily identified today.

Every increase of aperture above 4″ will add additional detail in the Maria and fainter shadings on the deserts of Mars. One can hardly ex-

(Continued on page 25)

METEOR FRAGMENTS

EDWIN E. FRITON

DID YOU SEE a Leonid? Or possibly even a Bielid? Such are the "singular" questions which meteor observers frequently ask each other after November is over. For this is the month when some of the most spectacular (and the most rare) events in meteoric history have occurred, and during which many observers have gone forth with great hope, but to return home with paltry little but disappointment.

First, there is the Leonid shower, due on Nov. 16 (and observed several times in uncounted numbers; and second, the Bielids, or Andromedids, last seen in great numbers (perhaps 75,000 an hour) on November 27, 1885, but now only seldom noted. A full account of the strange antics of these two meteor streams makes fascinating reading, but, unfortunately, only the gists of their stories can be related here.

In 1799, on November 11, the great naturalist, traveler and statesman A. von Humboldt observed an extraordinary meteor storm while in South America, and described it as "thousands of meteors and fireballs moving regularly from north to south, with no part of the sky so large as twice the moon's diameter not filled each instant by meteors." These meteors radiated from the constellation of Leo. Then, in 1833 came another great storm of Leonids, on November 12, when meteors were like snowflakes"—the rate was estimated roughly as 10,000 per hour. described as "falling from the sky November 13, 1886, saw a near repitition, and 1867 and 1868 each yielded about 1,000 per hour at maximum. Armed with this history, most astronomers confidently predicted that there would be another great return in 1899; professionals, amateurs, and the public alike were generally primed for another thrilling celestial show. But alas, only about 40 per hour appeared, causing, according to C. P. Olivier, ". . . the worst blow even suffered by astronomy in the eyes of the public."

One clear but virtually disregarded light shone in all this darkness: it seems that three men, Adams, Stoney, and Downing had investigated the orbit of the Leonids, especially with regard to possible perturbations by Jupiter and Saturn, and found that at the critical date in 1899, the Leonid stream had moved away from the earth to a distance of 1,300,000 miles. This fact (published in 1898) should have served as a caution. The last good return was on Nov. 16-17, 1932, when 240 per hour were counted. It is not generally expected that the stream will again approach us closely, but continued observations should be made. All data properly taken help fill in the gaps which still undoubtedly exist with respect to our knowledge of the stream.

The estimated time of maximum (based on data by Millman, RASC *Observer's Handbook*, 1960) is 6 a.m. CST on the 16th, at which time the rate for all meteors is expected to be only 15 per hour. The radiant is at R.A. 10h 8m, Dec. 22° N., which is in the "sickle" of Leo, near the star Gamma. The Leonids are swift and are frequently reported to give streaks of a deep bluish color. The stream follows the orbit of Temple's Comet, 1866-I. The moon will, by its absence, favor observations, as it will be new.

The other great shower of November was the Bielids, or Andromedids. Biela's Comet of 1826, whose period around the sun was 6.6 years, was closely connected with a stream of meteors which produced strong show-

(Continued on page 27)

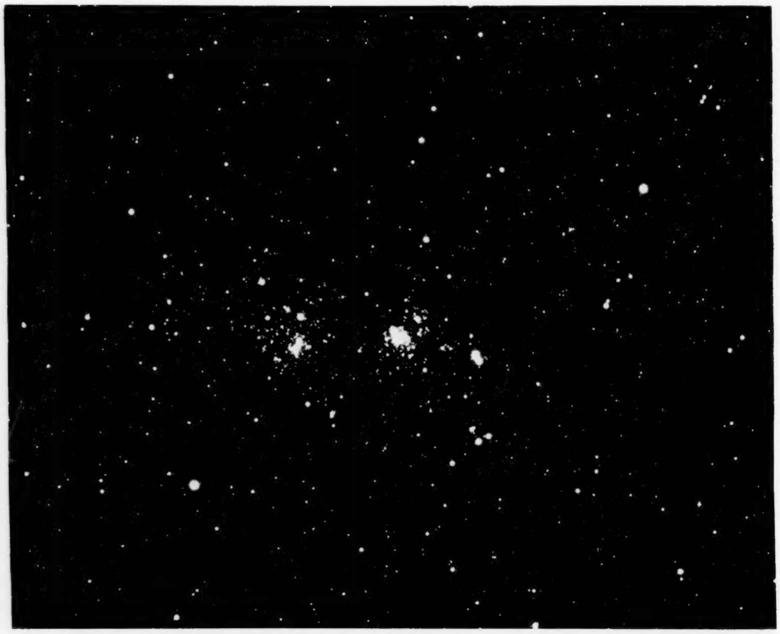
THROUGH THE THREE-INCH

ALL OBJECTS RECOMMENDED in these columns are pre-tested! This is a claim we are proud to make—and there are no witnesses to refute us. We have just returned from a small-hour excursion among the stars of the winter world—a sneak preview of the magnificent array of stars and objects which stud the winter heavens.

Our first glimpse of the winter skies is always an exciting experience—especially when it is obtained in early October. The weather took a crisp turn suddenly, we had napped after dinner, the family had turned in, and we began to wonder: are the evening skies of winter as grand as we recall? The temperatures, the lingering clouds, the business of winter—pull a veil across the memory and chill the brain. There is only one way to make certain that it is all true—that the December heavens really are a case of jewels, rare both in their intrinsic lustre and in their inaccessibility.

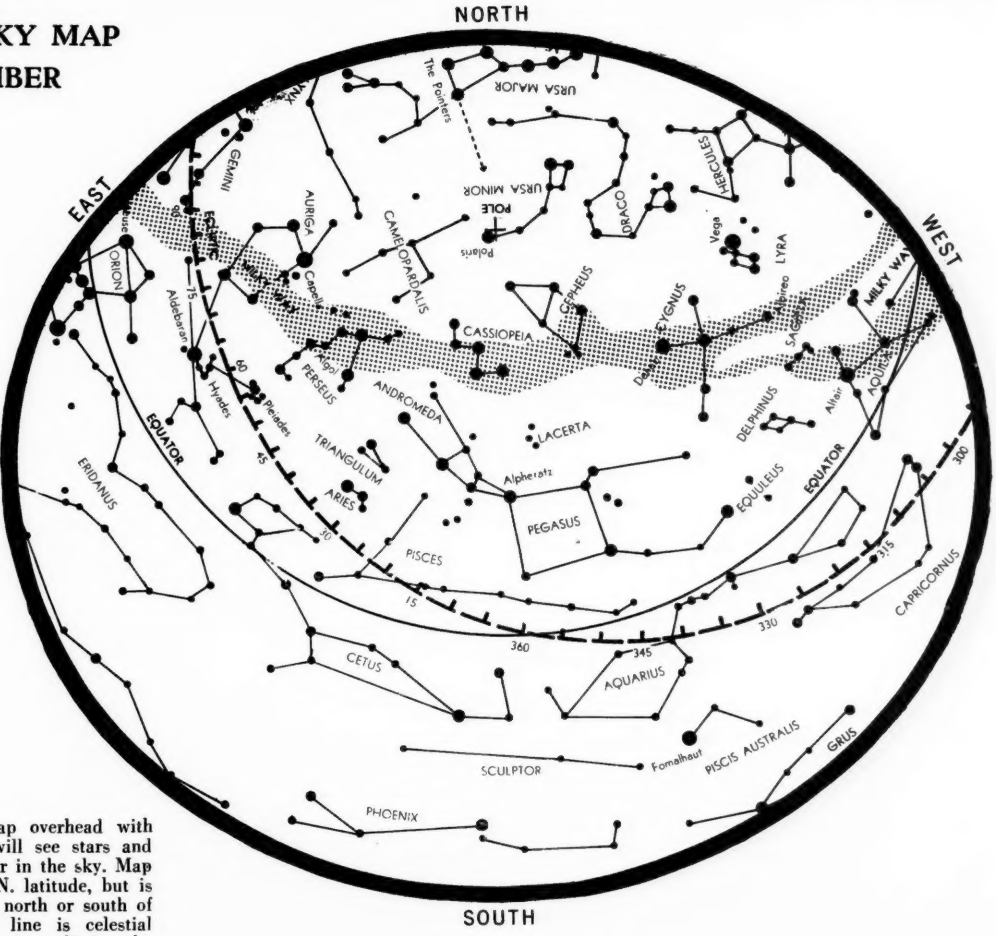
As we stepped out into the side lawn from the pleasant warmth of the den and looked up into the southern skies, we met little more than disillusion. The 3-inch Fitz and our RFT were at ready, but our eyes were not. Pisces, Cetus, Aquarius, Eridanus—all held many mysteries for the telescope, but little charm for the searching, hungry eye. The small stars of this arid region slowly began to pop out as our eyes adjusted to the unusual blackness (the preoccupation of city fathers with approaching elections had allowed them to overlook an extingu'shed street lamp before our house), but still there was little to see but the faint outlines of undistinguished constellations. We were loaded for bear, but were only flushing quail. But then, overhead, we became conscious of Cassiopeia and Perseus, winter's harbingers; they had sneaked up on us from the northeastern horizon. Beyond them to the east stretch Auriga and Gemini, continuing the splendid belt of clusters that begins in Cassiopeia.

The double cluster of Perseus is riding high in the crisp of autumn, a veritable jewel box there for the taking. Described variously as a collection of "gold dust" and "diamond dust," this is truly a wondrous pair of galactic clusters. They are located at about R.A. 2h 20m, Dec. 57° N.,



An amateur's photograph of the Double Cluster in Perseus, made with an f/7 7" e.f.l. Fecker triplet lens by Alan McClure of Los Angeles. Exposure was 22 minutes in blue light. Photographs, with their buildup of stellar images from small points, cannot convey the gem-like quality of this twin cluster of supergiant suns. **See page 34 for another McClure astrophoto.**

EVENING SKY MAP FOR NOVEMBER



Face south, hold map overhead with north at top. You will see stars and planets as they appear in the sky. Map is designed for 40° N. latitude, but is practical ten degrees north or south of that latitude. Solid line is celestial equator; dashed line is ecliptic, the apparent path of sun and planets.

9:30 p.m., Nov. 1 8:30 p.m., Nov. 15 7:30 p.m., Nov. 30

and lie below and to the left of the "W" of Cassiopeia, just across the border into Perseus. Shapley, with his perverse perspective, says that the 1,000-odd stars which comprise this double diadem would be evident to "astronomers" observing our stellar aggregation from the Andromeda galaxy. Twinkling at us through interstellar dust from some 8,000 light years away, the double cluster's red and blue supergiant suns make it an easy naked-eye object and a telescopic treasure chest.

The later hours of November and December evenings bring a magnificent spray of clusters. Capella, lurking in the trees to the northeast, carries upward with it a splendid catch of clusters within the borders of its companion stars in Auriga. Try these in low powers, then break them wider with medium magnifications:

M36 — 5h 33m, 34° 7′ N.; an "open splash of stars," notes Admiral Smyth, the English observer. Embedded in its midst is an easy double star.

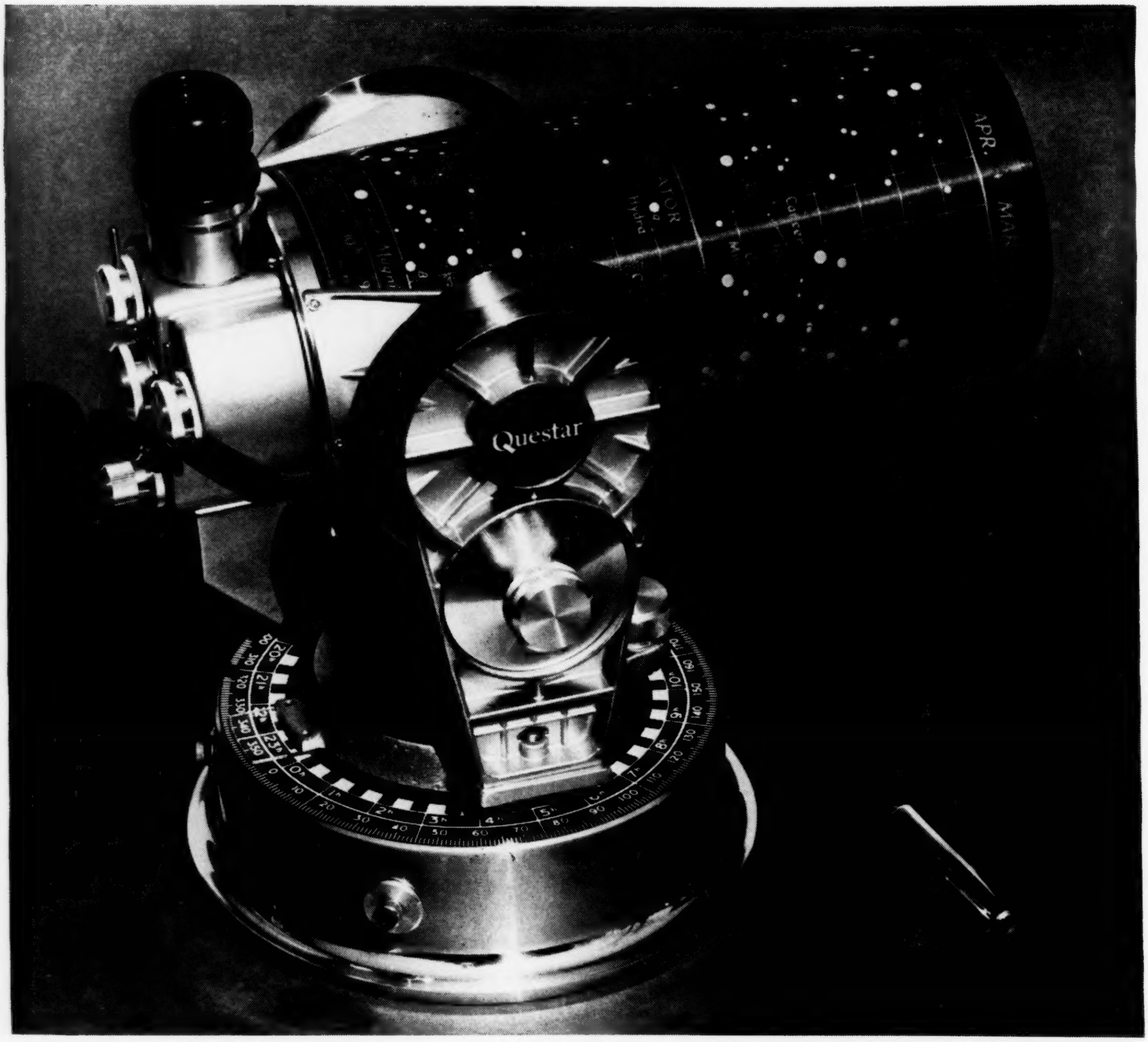
M37 — 5h 49m, 32° 33′ N.; another excellent open cluster: " . . . even in smaller instruments extremely beautiful, one of the finest of its class . . . gaze at it long and well," writes the Rev. Webb. Lord Rosse mentions loops and curves of stars, and they are there after a little inspection.

M38 — 5h 25m, 35° 48′ N.; the field beyond the actual confines of this open cluster is equally satisfying. Some observers are struck by the cluster's cross-like structure. Do you see it?

Resisting Mars for a moment as we move into Gemini, there is M35 at the foot of the Twins (6h 6m, 24° 21′ N.). It is quite open, rich in star streams, and in a rich field. Another ideal hunting ground for low powers, and especially an RFT.

Ending in Cassiopeia, you are on your own after a suggested stop at M103 (1h 29m, 60° 26′ N.), another open cluster with a double and a clear red star within it, with H31 (Herschel's classification) just to its east. These are just starters, for Cassiopeia is a fountain of rich and rewarding fields.

Try these open clusters for yourself—you'll soon grow to know and revere them for the continuing pleasure they afford.



LAY THAT BURDEN DOWN

When you finally get tired of lifting and carrying your telescope in and out of doors, tired of setting it up and taking it down in chilly darkness—

When you've had enough of heavy loads, of quivering tubes and images, enough of drives that falter and slow motions that fall short—

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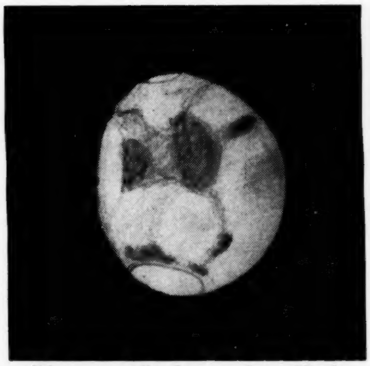
(Continued from page 20)
pect to see much, if any, of the controversial "canal" detail with less than about a 6-inch telescope; yet, years ago, W. H. Pickering observed a number of the broader canals with a 5″ refractor at Harvard. The beginning observer will soon find that if he devotes an hour to observing Mars each available night, his first disappointing views will quickly improve. This is simply due to the training of the eye and its increasing ability to see more detail on a small bright disc of light. Mars, because of its small angular size, requires more magnification—and bears high power better—than the other naked-eye planets. At least 200x or more is good on a 3-inch refractor, and 300x can be useful for Mars on a 4-inch, while 400x to even 500x can occasionally be helpful for a 6 to 8-inch reflector.

A regular program of drawing the planet will not only help in the detection of detail, but will greatly increase the observer's interest in the night-to-night observations. If Mars is observed at the same hour an successive evenings for a period of about 40 nights, then all the detail on the entire globe of Mars will have been seen. This approximately 40-day period is termed one presentation of Mars. Many observers find photographic color filters, particularly yellow, orange, and light red, very helpful in increasing the contrast in the *maria* of Mars and also to reduce the glare of the planet's light. With telescopes of small aperture the filters should not be dense, since most of the available light of Mars should reach the eye; larger apertures require denser filters to dim the glare of Mars and reduce irradiation (contrast) effects.



Disc was 8″ of arc when Clark Chapman made this drawing on Sept. 7, 1960, early in this apparition. Margaritifer Sinus is on meridian, but detail is obscure. Chapman used light red filter to enhance contrast.

A great deal of enjoyment and pleasure can be obtained by observing Mars at the coming apparition, and the newcomer to telescopic observation will perhaps find himself amazed at the amount of detail he can see after a few weeks of viewing the red planet. There is also a special thrill in viewing the Martian *maria*, which may well be made up of the only form of rudimentary plant life in all the solar system besides the earth.

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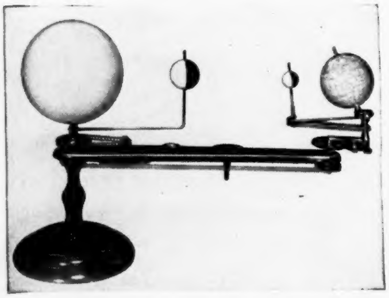

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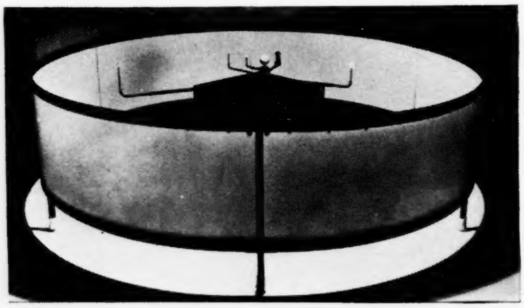

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(Continued from page 21)

ers as early as Dec. 5, 1741. A number of other appearances of the shower were seen at subsequent returns at hourly rates of from 100 to 400, or perhaps more, when suddenly, on Nov. 27, 1872, a veritable meteoric storm occurred, with rates of from 2,000 to 6,000. 13 years later, on the 27th of November, 1885, a much greater storm was observed, with an estimated rate as high as 75,000. The last good shower, that of 1899, produced about 100 meteors per hour. Recently, years have passed by in which very few or none have been seen—the Bielids are now known as one of the "lost showers."

Experienced observers should attempt observations during the last week in November and the first week in December, as the Bielids' distribution in their presently multiple orbits is not well known, and any possible return would be of much interest. Lovell, in his book *Meteor Astronomy*, gives Prentice's determination of radiants in 1940 as follows: Nov. 30, RA 1h 32m, Dec. 44.5° N; Dec. 2, 1h 56m, 45.5° N; and Dec. 4, 1h 32m, 41.5° N. These points are in the region just west of Gamma Andromedae.

December brings us one of the rich and reliable meteor showers of the year, the Geminids, which appear to radiate from about 1° north of Castor. The maximum is predicted (Millman, RASC *Observer's Handbook*, 1960) for about 1 a.m. CST on the morning of December 13, and is likely to be about 50 per hour. The duration of the shower is about six days. The meteors are a beautiful sight, as they are white and leave rich-looking trails. A last-quarter moon will reduce the apparent rate somewhat, mainly during the after-midnight hours. The Geminid meteor stream has, as yet, no known cometary association.

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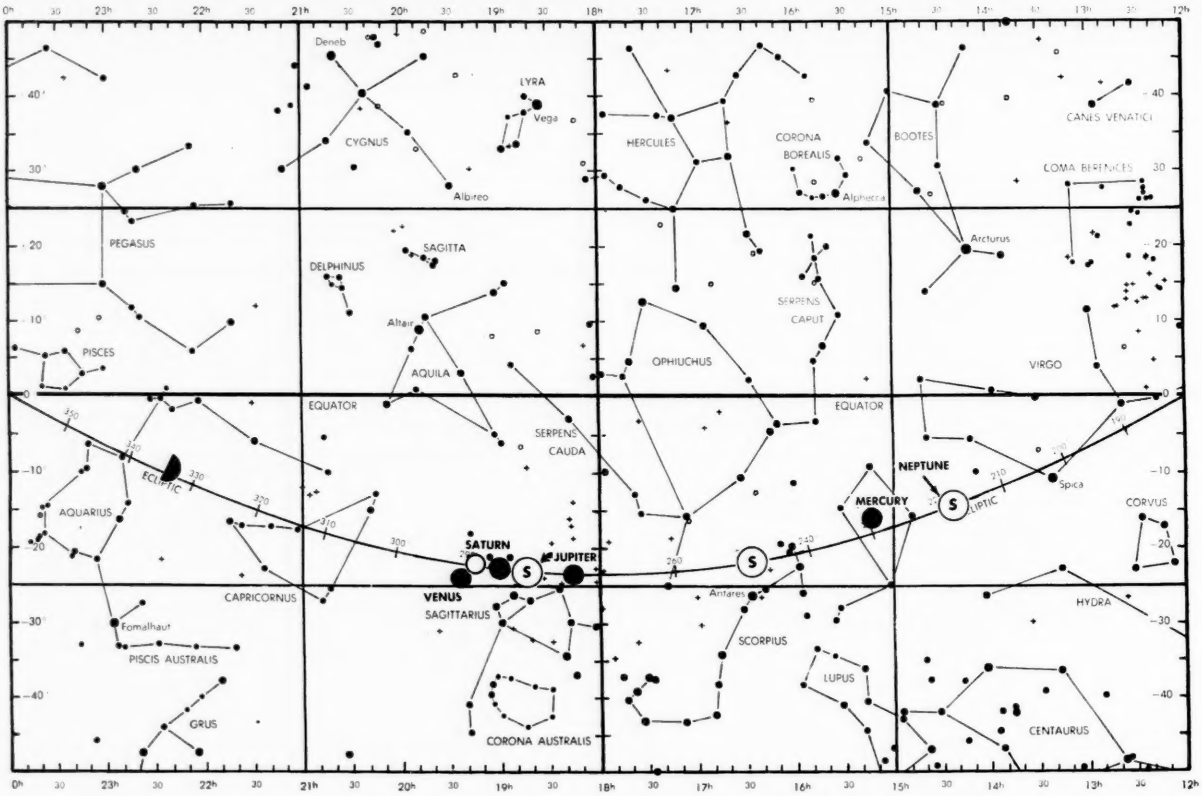


The charts on these pages show the star field from the equator to 50° south and 50° north. Right ascension is measured from west to east in hours; each notch at the top and bottom of the charts represents 10m of right ascension. Declination is measured to the north and south of the equator in degrees plus or minus; each notch at the right and left of the chart represents 5° of declination. Longitude along ecliptic is measured in 10° segments.

EQUATORIAL SKY MAP

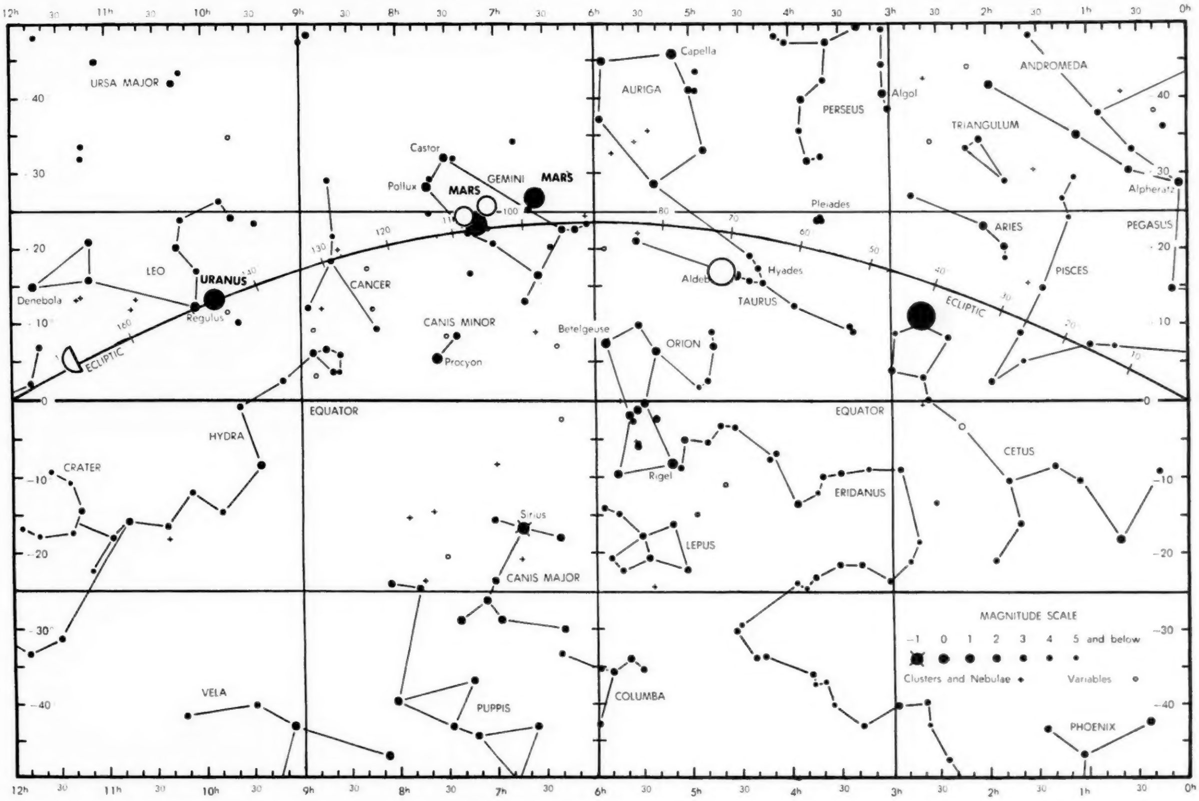
NOVEMBER AND DECEMBER AMONG THE PLANETS

SUN: On Nov. 1 the sun is in Libra at RA 14h 25m, Dec −14° 22′; by Dec. 1 it has moved into Scorpius and is at RA 16h 28m, Dec −21° 46′. At 3:00 p.m. Eastern Standard Time on Dec. 21 the sun reaches the winter solstice, and winter is finally ushered in (officially). The U. S. Weather Bureau, a more practical group of people than our astronomers, begins *its* winter on December 1, a much more realistic date. On Nov. 1 the sun's distance from the earth is 92,280,000 miles; by Dec. 31 this distance has decreased to 91,400,000. Actually, the sun is closer as the temperatures become lower, but, as we know, this has little influence on terrestrial temperatures. It's the angle the sun's rays make with the earth's surface which affects our temperatures, and in winter—in the temperate zone of the northern hemisphere—the angle of incidence of the solar rays is relatively small. In late December, for example, the sun is just a bit more than 25° above the southern horizon at noon at the latitude of 40° N., so its effective insolation, or heating effect, is spread over a greater surface area. However, it is not until January and February when our lowest winter thermometer readings are made, since there is a bit of a lag in the cooling of the air around us.

MERCURY: The 10-day positions of Mercury are shown on the chart of Mercury and Venus elsewhere on these pages. Mercury reaches its greatest western elongation from the sun on Nov. 20 (20°). It is at perihelion on Nov. 12; at aphelion on Dec. 26. On Nov. 1 Mercury is magnitude 0.8, but by the end of December it has brightened to −0.8. At its elongation it can be glimpsed low in the southeast before sunrise, shining at about zero magnitude.

On Nov. 7 at 8:34 a.m. (EST) Mercury will transit the sun, its black disk being silhouetted against the bright background of the sun. For details, see page 32 of this issue.

VENUS: The 10-day positions of Venus are shown on the special Mercury-Venus chart elsewhere on these pages. The planet is becoming more and more conspicuous in the southwestern sky after sunset, shining at −3.4 on Nov. 1 and brightening to −3.8 at the end of

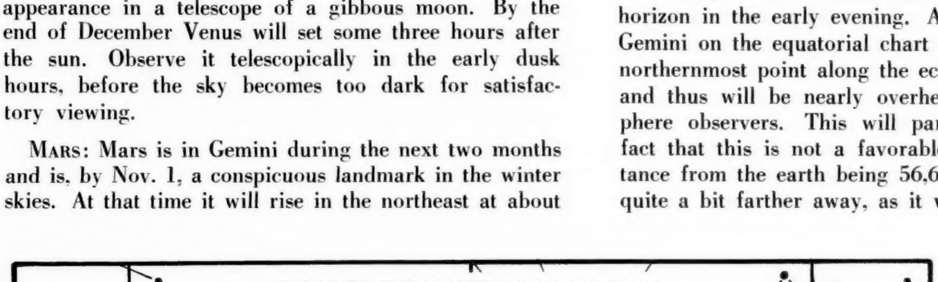


Charts indicate position of sun for 1st of each month. Mercury and Venus are shown only for middle of two-month period (see special map below for 10-day positions). Mars is plotted for 1st and 15th of each month; Jupiter and other planets for 15th of each month. Position and phase of moon is also indicated. Positions of moon and planets in November are shown by *black* circles; for December by *outlined* circles.

Chart is a natural projection and contains all stars through fifth magnitude (and some fainter). Bright stars are labeled with their proper names. Clusters and nebulae in Messier's catalogue are included, as are all variable stars with maxima brighter than magnitude 8.0. Circumpolar stars may be located on the evening sky map for the appropriate month.

December. Its apparent disk increases in size during this period from 13″ to nearly 19″ of arc. On Nov. 1 it is 82% illuminated, and as the disk enlarges this percentage of illumination drops to 64%, giving the appearance in a telescope of a gibbous moon. By the end of December Venus will set some three hours after the sun. Observe it telescopically in the early dusk hours, before the sky becomes too dark for satisfactory viewing.

MARS: Mars is in Gemini during the next two months and is, by Nov. 1, a conspicuous landmark in the winter skies. At that time it will rise in the northeast at about 9:00 p.m. local standard time, but the viewing, at least, telescopically, will not be good until later in the evening when it is more favorably placed. By December, of course, it will be at a favorable altitude above the horizon in the early evening. A look at its location in Gemini on the equatorial chart shows that it lies at its northernmost point along the ecliptic at this opposition, and thus will be nearly overhead for northern hemisphere observers. This will partly counter-balance the fact that this is not a favorable opposition, Mars' distance from the earth being 56,600,000 miles. It can be quite a bit farther away, as it will during the next few



Mercury and Venus at 10-day periods from Nov. 1 to Dec. 30, 1960. Sun is shown for first of Nov., Dec., Jan. Planets move right to left.

oppositions, but it can also be closer (35,000,000 miles).

On Nov. 1, Mars will shine at –0.3, and will exhibit a disk of about 11″ of arc; by Christmas, it will be at its nearest point to the earth, showing a disk of nearly 16″ of arc and having a magnitude of –1.3. Opposition with the sun is reached on Dec. 31, as Mars wishes us a Merry Christmas and a Happy New Year (as does the staff of the SKY MAP to its readers!).

JUPITER: The great planet, losing a bit of distinction temporarily, moves from Ophiuchus into Sagittarius during the next two months. On Nov. 1 it is at RA 18h 05m, Dec –26° 26′; by the end of December it will have moved to RA 19h 00m, Dec –22° 49′. Since it will be moving into the evening twilight during November, the satellite position and phenomena tables on page 31 are included only for November. They will be resumed when Jupiter is once more favorably placed for observation after conjunction with the sun early in 1961. Jupiter will have a magnitude of –1.5 during November; its disk will be about 33″ of arc.

SATURN: Saturn is in Sagittarius, less than 10° west of Jupiter. On Nov. 1 its position is RA 18h 59m, Dec –22° 34′; on Dec. 31, RA 19h 24m, Dec –22° 49′. Its average magnitude during these two months is 0.8, the diameter of its rings about 33″. It is also moving into the twilight sky in the early evening, and is of decreasing interest to observers, although drawings and observations of any planet at the end of an apparition are of value if made with larger instruments by experienced planetary observers.

URANUS: Uranus rises during the morning hours in Leo and is of little interest.

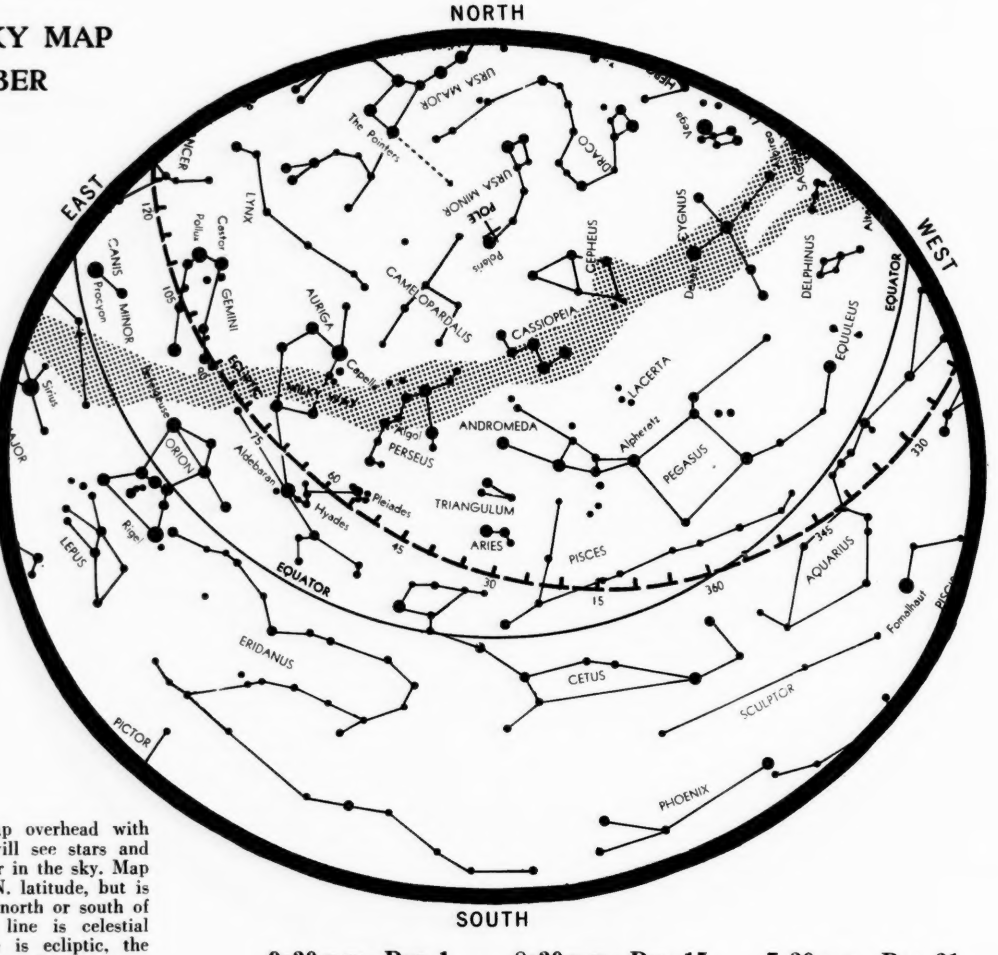
NEPTUNE: Neptune is between Virgo and Libra, rising just before dawn.

PLUTO: Pluto is in Leo, some 3,169,105,200 miles away on Dec. 1. You're on your own on that one!

LET'S LEARN ASTRONOMY

"Let's Learn Astronomy," new department by science instructor Robert Burkham, will be continued in Jan.-Feb., 1961 issue. Mr. Burkham's subject will be the plotting of accurate heliocentric orbits of the planets, an interesting and profitable project for both students and armchair astronomers.

EVENING SKY MAP FOR DECEMBER



Face south, hold map overhead with north at top. You will see stars and planets as they appear in the sky. Map is designed for 40° N. latitude, but is practical ten degrees north or south of that latitude. Solid line is celestial equator; dashed line is ecliptic, the apparent path of sun and planets.

9:30 p.m., Dec. 1 **8:30 p.m., Dec. 15** **7:30 p.m., Dec. 31**

SKY WATCHER'S DIARY

NOVEMBER

Date	Hour (EST)	Event
1	02	Neptune in conjunction with sun
3	07	Full moon
5	13	Aldebaran 0°.4 S. of moon
7	12	Mercury in inferior conjunction, transit over sun
8	19	Mars 6° N. of moon
9	04	Moon at apogee
11	09	Last quarter
11	23	Uranus 2° N. of moon
12	20	Mercury 0°.2 S. of Neptune
16	09	Mercury stationary
17	11	Mercury 2° S. of moon
17	13	Neptune 3° S. of moon
18	19	New moon
18	21	Venus 2° S. of Jupiter
20	14	Mercury 0°.8 N. of Neptune
20	23	Moon at perigee
21	00	Mars stationary
21	10	Jupiter 5° S. of moon
21	14	Venus 7° S. of moon
22	03	Saturn 4° S. of moon
24	03	Mercury greatest elong. W. (20°)
25	11	First quarter
28	02	Venus 2°.4 S. of Saturn

DECEMBER

Date	Hour (EST)	Event
1	06	Uranus stationary
2	20	Aldebaran 0°.5 S. of moon
2	23	Full moon
6	01	Mars 7° N. of moon
6	22	Moon at apogee
9	07	Uranus 2° N. of moon
11	05	Last quarter
13	03	Mercury 5° N. of Antares
15	01	Neptune 3° S. of moon
15	22	Pluto stationary
18	05	New moon
19	05	Moon at perigee
19	17	Saturn 4° S. of moon
21	10	Venus 4° S. of moon
21	15	Solstice
24	21	First quarter
25	01	Mars nearest to Earth
30	02	Aldebaran 0°.4 S. of moon
30	05	Mars at opposition

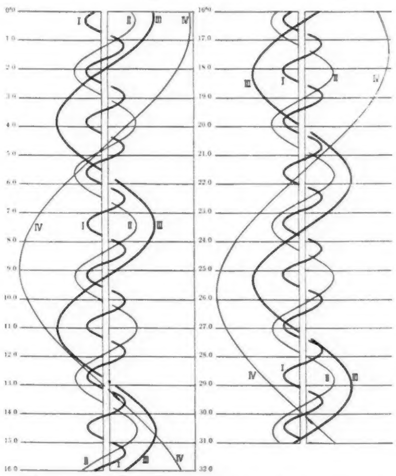
PHENOMENA OF JUPITER'S SATELLITES FOR NOVEMBER

Date	Time (EST)	Satellite	Phen.
1	18:17	III	TI
4	18:14	IV	SI
5	19:36	I	OD
6	19:13	I	Te
9	19:44	II	OD
11	18:27	II	SE
12	19:28	III	ER
13	18:59	I	TI
	19:50	I	SI
14	19:13	I	ER
18	18:19	II	SI
	19:28	II	Te
21	18:08	I	OD
22	18:28	I	SE
25	19:34	II	TI
27	18:47	II	ER
28	20:09	I	OD
29	18:08	I	SI
	18:57	IV	OR
	19:46	I	Te

(Times EST) E—eclipse (satellite passes into shadow of planet); O—occultation (satellite passes behind planet); T—transit (satellite or satellite shadow passes across disk of planet); S—shadow (shadow of satellite cast on disk by sun); D—disappearance; R—reappearance; I—ingress (entrance upon disk); e—egress (exit from disk). Satellite designations: I—Io; II—Europa; III—Ganymede; IV—Callisto.

(Data adapted from 1960 American Ephemeris and Nautical Almanac.)

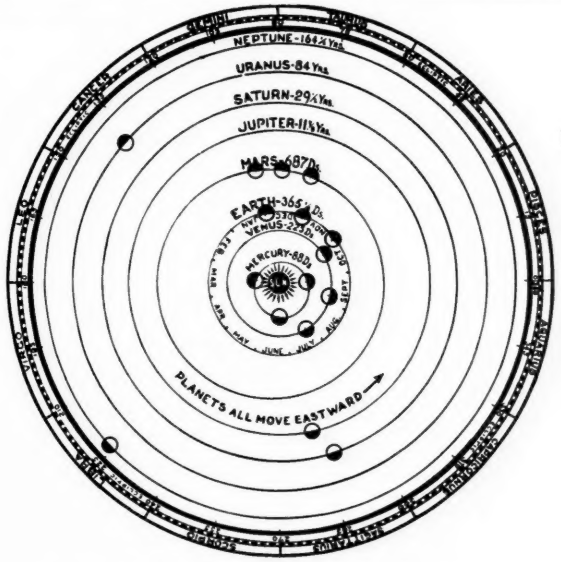
SATELLITES OF JUPITER—NOV. 1960
(Universal Time)



The central vertical band in the diagram represents the equatorial diameter of the disk of Jupiter. The relative positions of the satellites at any time with respect to the disk of Jupiter are given by the curves. In cases where a satellite is immersed in the shadow of Jupiter or occulted by its disk, the curve is interrupted.

The horizontal lines show the positions of the satellites at 0h Universal Time (Greenwich Mean Time) for each day of the month. For example, the horizontal line for the 15th of this month would show the positions of the satellites at 7:00 p.m. on the 14th of the month for an observer in the Eastern time zone.

(Diagrams taken from 1960 *American Ephemeris and Nautical Almanac.*)



HELIOCENTRIC POSITIONS of the PLANETS for NOVEMBER and DECEMBER 1960

This chart shows the solar system as it would appear if viewed from a point directly above the sun (in relation to the plane of the ecliptic). Heliocentric positions of the planets are measured in degrees of longitude, eastward from the First Point of Aries. Owing to space limitations, the orbits of the planets are not to scale. Positions at beginning, middle and end of two-month period are shown for Mercury, Venus, Earth and Mars—mean position during period is shown for each of the outer planets.

MERCURY TRANSIT NOV. 7th

On Monday, November 7, 1960, a transit of Mercury will take place, affording all those having telescopes a chance to see this important astronomical event. As the transit occurs on a week-day morning, many amateurs may have to forego this opportunity, as duty may call them to less exciting endeavors.

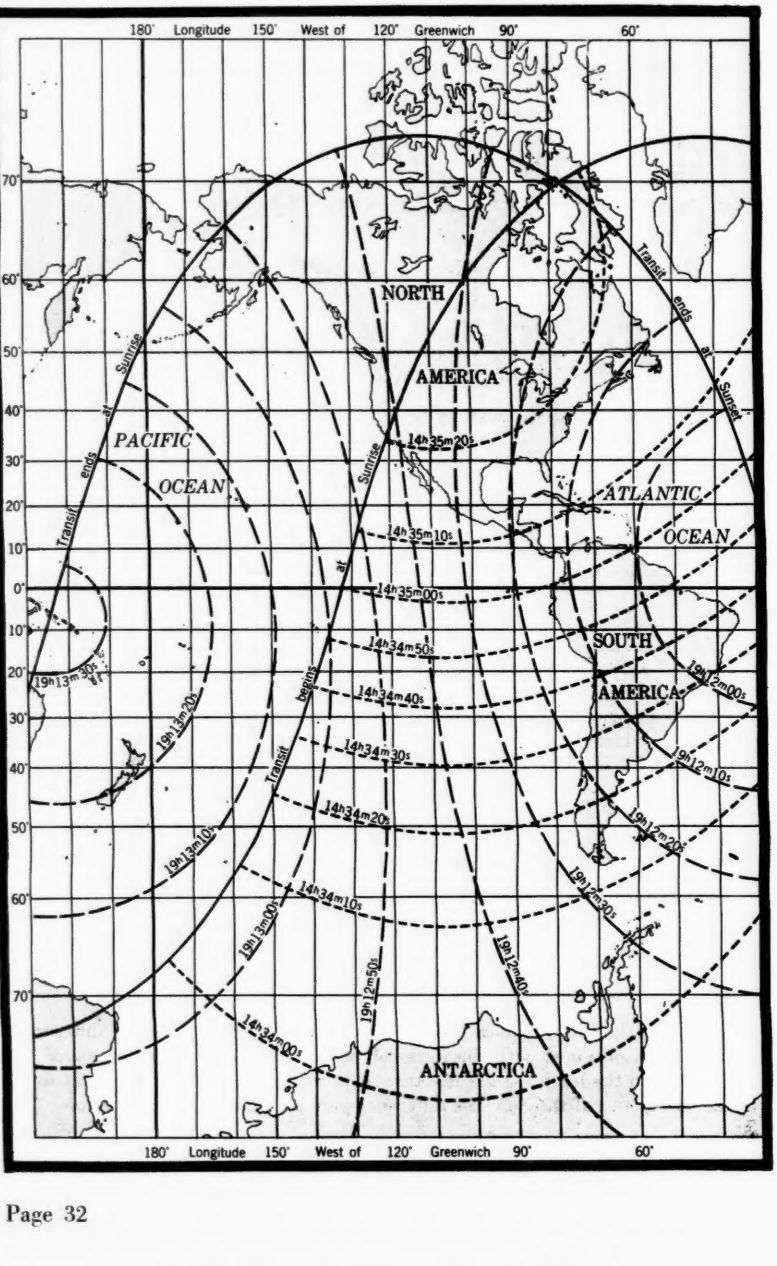
Observers throughout most of the United States, Canada and Central and South America may see the entire transit, which will begin about 8:34 a.m. Eastern Standard Time, and end 2h 48m later at 11:22 a.m. Viewers on the extreme West Coast of the United States, in northwest Canada, Alaska, the mid-Pacific Ocean, and in the south Pacific as far as eastern Australia and New Zealand, will see the end of the transit, but the beginning will have occurred before sunrise.

A transit of Mercury (or Venus) is the passage of the planet directly between the sun and the earth, at which time it appears as a small black dot silhouetted against the bright disc of the sun. Transits can occur only within certain limits of distance from the nodes of the planet's orbit—the nodes being the two points at which the orbit intersects the ecliptic. Mercury can transit the sun in November when it is within 4¾° of the ascending node, and in May when it is within 2¾° of the descending node. November transits are, therefore, the most numerous. A transit occurred in 1953, seven years ago, but most often the time between November transits is 13 years. The May transits never occur at closer intervals than 13 years. After one transit, either in May or November, we are certain to have one at the same node 46 years later. There will be no transit of Venus this century.

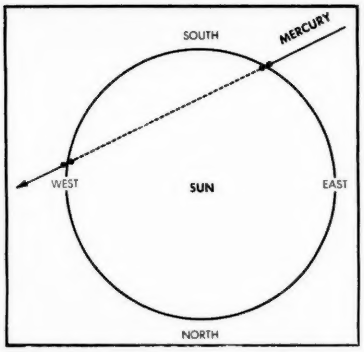
Many transits of Mercury have been observed since Gassendi, in 1631, proved the future usefulness of Kepler's tables of the planets by his first observation of the phenomenon. Today, observations of the times of contacts of Mercury with the limb of the sun are continued to refine the elements of its orbit.

Observing a transit is not at all difficult, although a telescope is required to see the very small disc of Mercury. As with solar observing, caution should be used in dealing with the intensely hot rays of sunlight collected by the objective. The safest method would be to project the sun's image through the eyepiece onto a piece of white paper where several persons may watch together. If the white screen is placed at the bottom of a light cardboard box having no lid, the sides will help shade the image from scattered sky light, enhancing the contrast and permitting a larger image to be projected.

Soon after first contact, a very small notch will be seen in the sun's limb about 30° from the south point toward th eeast. This will become larger as the planet enters farther onto the sun's disc. Often, when the planet is more than halfway on the disc, a "black drop" effect is seen, but not always. This gives the illusion that the planet is partially adhering to the sun's limb, as would a drop of liquid. At the second contact, when the planet is entirely inside the limb of the sun, but tangent to it, two

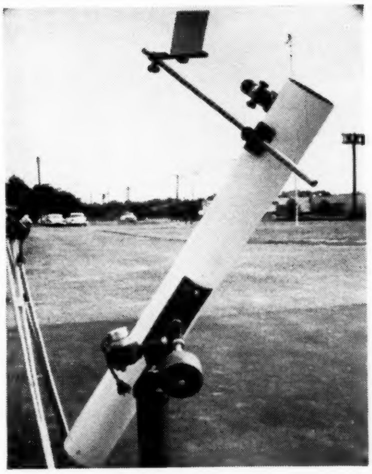


Map showing Universal times of first contact (short broken lines) and second contact (long broken lines) of Mercury with sun's limb. Subtract 5h to obtain EST. Adapted from "American Ephemeris."



Path of Mercury across disc of sun in an inverting telescope. Points along line show four contact points during transit. Let sun pass through field of view to determine E-W orientation.

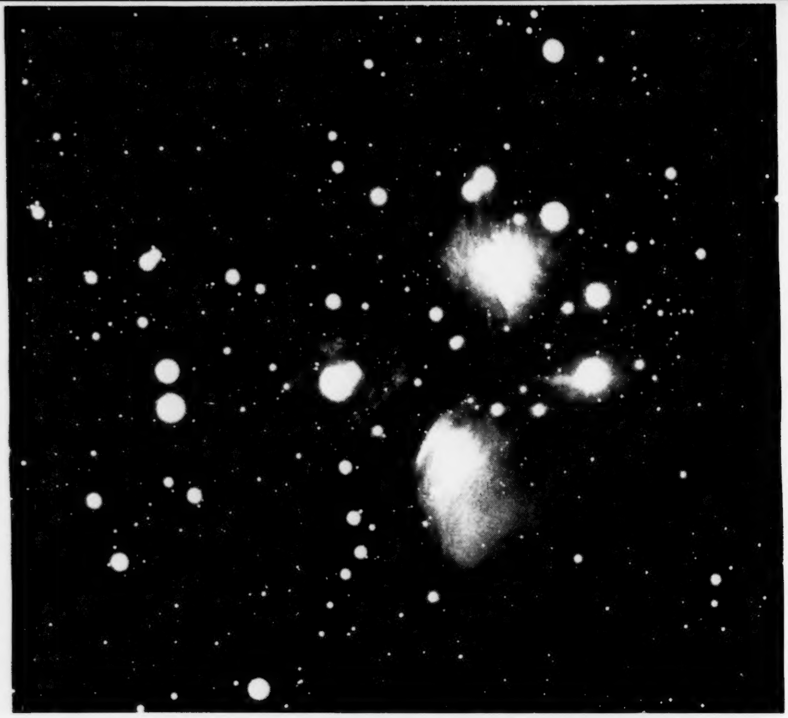
A small reflector adapted to project solar image. Cemented eyepieces should not be used; heat of sun can melt balsam. Use Huyghenian or Ramsden ocular.



"horns" of the bright sun will close in behind it, and when they join is the instant of second contact.

The planet will cross the sun's disc toward a point about 18° south of west, where the third contact will be made. The path will cross the southwestern part of the sun, reaching a point a little less than half way from the limb to the center at its deepest penetration. As the planet approaches third contact, the two horns of light will again become apparent, and possibly the "black drop" effect will be noted once more. Finally, at the instant of contact the "horns" will separate, and Mercury will begin crossing the limb. An ever-decreasing notch in the limb will signify the coming end of the transit.

Stuart L. O'Byrne



Always an attraction in the winter skies, the "tangled braid" of the Pleiades will share the Gemini-Taurus region with Mars during November and December. This 22-minute blue-light exposure was made with a 7" f/7 Fecker triple lens by Alan McClure. Nebulosity surrounding Merope and other "sister" stars is prominent in this striking amateur photograph.

(Continued from page 7)

The observer—beginner or advanced—should calculate the Martian longitude which is on the meridian (center of disc around opposition) and *then* relate what he sees on the oriented map. This prevents any misidentification which might arise from over-confidence and from the superficial similarity of many Martian features.

A table has been included which will enable the reader to calculate roughly the longitude of the Martian meridian during the next two months. Martian longitude on the meridian (geometric center of disc) at 7:00 p.m. EST is given for 5-day periods during November and December. A feature on the meridian one night will appear on the meridian 37m 22s later the next night; or about 9°.1 to the east (following or trailing limb). The planet rotates through 14°.62 in an hour, or about 350°.89 in a day.

LONGITUDE ON MARTIAN MERIDIAN (7:00 P.M. EST)

Nov.	1	77°	Dec.	5	127°
	5	40°		10	82°
	10	354°		15	38°
	15	308°		20	354°
	20	262°		25	310°
	25	217°		30	267°
	30	172°			

Certain features will be visible in a small instrument under favorable seeing conditions. The north polar cap; Sinus Sabaeus and its western prominence, Dawes' Forked Bay (from which Martian longitude is measured); Mare Cimmerium and Mare Tyrrhenum with the whitish Hesperia separating them; the always conspicuous Syrtis Major and the Nepenthes-Thoth "canal" to the northeast; the Margaritifer Sinus with its occasionally well-defined dark tip—these are but a few of the markings which the attentive observer using modest equipment may find during this opposition.

The *maria*, dark green or grayish against the orangish-ochre of the "desert" areas, are thought to be regions of primitive vegetation—probably lichens or reindeer moss—while the reddish areas seem to be very much what they seem: deserts. The climate of Mars can roughly be described as a combination of the Sahara Desert and the hurricane regions of the Caribbean, taken to the North Pole and elevated about 20,000 feet! People manage to live in all of these areas, but the combination as it probably exists on Mars is singularly unappetizing. The Martian spring is possibly a bit overrated—unless you're a Martian.

Yet Mars is the only planet whose surface we can see effectively, and this very fact has made it the subject of study and speculation that has stretched both man's mind and his imagination to the near-breaking point. As modern amateurs know, the "canal" concept resulted from a mistake in translation of the Italian word "canali," meaning "channels." Percival Lowell, however, chose to interpret this literally and drew maps showing hundreds of canals in complicated geometric networks. He supposed that these canals fed the arid vegetation regions by bringing down for irrigation the melting ice of the Martian polar caps which become increasingly smaller as spring and summer set in. He pointed to a correlation between the diminishing size of the polar cap and the increasing darkness of the *maria*.

Modern observers suggest that these "canals" are actually optical illusions caused by chance groupings of unresolved surface markings, and enhanced by the eye's tendency to "conjure" straight lines between two points. Other Mars authorities hypothesize that these lines—which *are observable* in moderate instruments—are contrast effects between areas of unequal brightness. Regardless of this, it is an oversimplification and an injustice to one of astronomy's greatest visual observers to disregard completely the work of Lowell. He was a man of intellect and visual acuity, working in an area of excellent seeing conditions with one of the most optically perfect telescopes ever constructed. Even though Lowell's researches may have at times lost their objectivity, the beginning Mars observer can benefit from the articles and books written by and about this fascinating man and the work of the Lowell Observatory at Flagstaff, Arizona.

Naturally, a subject as extensive as the study of Mars cannot be covered in a brief article such as this. A number of popular books on Mars are available in libraries and bookstores, and the reader should avail himself of some of these to expand further his knowledge of this mysterious planet. It will be our "star in the East" this Christmas Eve—and it may be our destination in space a few years in the future. Regardless, a night spent with Mars, alone and chilled in the winter cold—waiting for those momentary "holes" of good seeing when the Martian surface details hang before us like a delicate steel engraving—is a night to be remembered and repeated.

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